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R. M. Johnston Memorial Lecture

Science and Sea Fisheries with special reference to Australia

By

WILLIAM JOHN DAKIN, D.Sc., F.Z.S.

Professor of Zoology, University of Sydney, N.S.W.

With 2 Plates and 3 Text Figures

(Read May 30th, 1934)

FOREWORD

One of my very worthy predecessors has indicated in his inimitable way the difficulties which face anyone honoured by election to deliver a lecture which has been instituted to bear memory to a great pioneer. There is to my mind always much difficulty in framing those lectures which are expected to do justice to a seat of office. The task is, however, immeasurably greater when a lecture is to serve as an offering in memory of a great man. The best I can do is to choose a subject close to my heart and I have selected one associated with the sea for I was first trained in a school of Marine Zoology at a University in a great seaport—that of Liverpool in England, and since I was by nature fond of the sea, my investigations have practically always been associated with marine problems. Whether the work was what some would call of pure scientific value or not, it has almost always been intimately connected with fishermen and fishery problems.

I make no apology, however, for selecting a subject associated with the sea and its products. The history of Hobart Town itself, its early pre-eminence in whaling and shipbuilding, is fortunately somewhat familiar to me. Is not this the obvious place for discoursing on sea products? But that is only to provide the background. The man whose memory we honour this evening was one of Tasmania's pioneers in the fishery problems. For several years he was a member of the fishery boards. He was the author of a number of papers on fishes. Moreover, if it were Johnston's hobbies—geology, zoology, and botany—which claimed the attention of his brother scientists, may I say that Biological Science to-day is becoming in many fields a statistical science, as you will see tonight. R. M. Johnston's life work was that carried out as the pioneer Government Statistician for Tasmania.

I render my homage gladly and humbly to his name. Australia has urgent need to-day of servants with such broad outlooks.

INTRODUCTION

I need not labour the point that Applied Science has changed the world completely in the last century. There are some who say for the worse. It is very difficult to see how that idea can be upheld if even a cursory observation of current economic problems is made. Any discoveries reducing the demands for labour in one field are, or should be, balanced by discoveries and inventions which have required more labour in other fields. The increased production in wheat and other foodstuffs cannot honestly be claimed to have resulted in over-production whilst thousands remain underfed. Again, the discoveries of medical science have removed altogether many horrors of life; and it would almost be ridiculous for me to try and tabulate the results of discoveries in, say, the field of electricity. Rather would I suggest that it is man's business organization that is at fault in these hours of trial, and especially his political systems. The world is almost controlled as if modern science had never existed, and by those who are still the products of an ancient educational system, ignorant of scientific method, although every day the effects of science lie plainly before our eyes.

In no branch of modern life has science played a more important part than in its relations with our food supplies. It has enabled the farmer to grow far more than two ears of corn where only one grew before and in addition has aided him in battling with drought and crop diseases. We have discovered the mechanism of heredity and the laws to be observed in breeding animals. We have learnt how to preserve our food, to convey it from one end of the earth to the other. We can make up the deficiencies in the soil by chemical products, so that there is food enough for richer plant growth, and we are still seeking better and better means of economically nourishing our live stock. The great science of Agriculture with its sister branches of knowledge is now represented in our universities and farm schools.

There is one great area of the earth's surface, however, where we reap without sowing, indeed in most places without knowing how best to reap, and whether we do it wisely or dangerously. That area is represented by the Sea.

There was a time when man neither cultivated crops nor worried overmuch about the extent of his hunting. But long before history left us anything in the way of records, the culture of plants and the domestication of animals had been practised. Before the dawn of modern science man had obtained much knowledge along these paths.

As concerns a similar investigation of the sea we are still only moving out of the primitive stages. We in Australia are particularly backward and in many respects scarcely out of an unusually primitive hunting stage.

It has been carelessly said that Australia has the greatest fishing coast in the world. In what way is this true? Taking the whole of our coast into consideration and estimating the area between it and the 200-fathom line, the result is 644,000 square miles. Of this probably 65 per cent. lies north of the latitude of Rockhampton, 23½° S. (in Queensland.) We are left with 145,385 square miles if we take the fishing area off the coasts of New South Wales, Victoria, Tasmania and South Australia. Now the trawling grounds alone of Europe are well over 680,000 square miles in area, that is to say, greater than our whole total, and these are all proved fishing areas. (The Mediterranean is completely left out in this calculation.)

As regards Australian production we have been told (Reports of the Australian Fisheries Commission, 1929) that the fishery of Victoria is confined almost solely to the bays and inlets along the coast and that these are now fished to capacity. Yet there is practically no deep water fishery off the East Victorian coast except what is carried on by a few Sydney trawlers. The fishery of South Australia again is chiefly in the St. Vincent's and Spencer's Gulfs and is equally the result of small scale fishing. The Great Bight remains more or less a *mare incognitum*. The Tasmanian fisheries are mainly those of the south-east, extending from Recherche Bay to Schouten Island, based on Hobart, and the other regions such as the west and north-east are said to be hindered by bad weather or lack of transport facilities. That excellently situated region of sea, the Bass Strait, is supposed to be relatively unproductive. Like most other areas the Tasmanian fisheries are also mainly served by hand lines and seine nets.

The fishing industry of Western Australia is as primitive as those of the States mentioned above and even more localized. Only in New South Wales has an effort been made to use the methods of large scale commercial fishing, but even here as much fish comes from the estuaries and other land-locked waters as from the ocean fisheries and the inshore fisheries employ about one thousand eight hundred persons directly as against say 200 on the deep sea trawlers.

Now the N.S.W. trawlers have only been at work 19 years, yet during the past five years the captains have complained of scarcity of fish and the voyages have increased from three or four days to seven or eight days. Are the complaints justified? If they are, can the matter be explained? Has over-fishing already resulted in depletion? I bring this last query into my introduction because the first stimulus for the application of science to Sea Fisheries may be traced to the origin of a similar fear of *depletion* in other parts of the world where catches appeared to be falling off. The initiation of a scientific study was not due to a desire to *increase* the yield of the sea beyond its previous fertility, but to explain diminutions and then, if possible, to bring the fertility back to that which was supposed to be the original state.

In Australia we are in the position that most of our fishing areas are still unknown and rest almost in the virgin state, crying for exploration. Yet, as if to emphasize the need from the outset for information along scientific lines, the only sea area which has been seriously worked already presents problems and alarums.

I do not intend to trace the history of the world's *great* fisheries here. It will be sufficient to note that the dawn of a new era came with the application of steam to fishing vessels and the tremendous development of trawling in the nineteenth century. Trawling as a well-defined mode of fishing in the North Sea expanded gradually during the years between 1800 and 1860 but it was after 1880 with the utilization of steam trawlers, that events moved faster, to culminate with the discovery and adoption of the otter trawl after 1895.

Of course biological discoveries of some importance in regard to fisheries were made before the comparatively recent dates I have given here, because there were zoologists interested in the sea and its life from the time of that great pioneer Aristotle. Indeed one of the outstanding scientific discoveries bearing upon fisheries was that of Professor G. O. Sars of the University of Christiania, who discovered in 1864 that the eggs of the cod fish, and other important food fishes floated in the surface waters of the sea after extrusion and fertilization, and underwent their development until hatching took place in these surface waters. Yet even now it is a popular belief on the part of fishermen that the sea fish lay their eggs on the sea bottom where they are destroyed by trawlers.

Complaints about over-fishing in the North Sea came to be potent about 1863 when the English Government appointed a commission to enquire 'whether or not the value of the fisheries was increasing, stationary, or decreasing; whether or not the existing methods of fishing caused permanent injury to the fishing grounds, and whether an extension of existing legislation was necessary.'

Allegations that trawls destroyed the eggs of sea fish and that depletion was occurring were again brought before an English commission in 1878. Between these dates, however, German scientists became more directly interested in sea-fisheries, and in 1870 the Royal Prussian Commission for the Scientific Investigation of the German Seas was established—the first definite organization of science in its application to sea fisheries. Other countries were close together in this evolution of interest in sea fisheries. Supposed depletion had just occasioned the appointment of a Fisheries Commission in the United States and a Report was issued in 1871 on the decrease of food fishes on the Coast and in the Lakes of U.S.A. This Report is particularly interesting for the consequences which led to the formation of the United States Bureau of Fisheries and the application of science on a larger and better organized scale than anywhere else.

The wave of inquiry seems almost to have been world-wide about 1865-1875, and even in 1870 it is said that Dutch herring boats were supplied with thermometers and notes relating to their use, because it had been discovered that more herring were caught at temperatures between 12° and 14° C. than under other conditions. The Russians, too, were making researches in the Baltic and the White Seas. The first British effort on a serious scale came with the Scottish Fishery Board's inquiry in regard to Herring towards the end of the 'seventies.

Fishery Boards in Scotland were years ahead of England in their activities. Scotland was not only collecting information as far back as 1850-1860 but was encouraging scientific investigations. (Natural History of Herring 1843-47 by Goodsir and Wilson. Herring Eggs, Dr. Walker 1803.) Huxley himself devised forms for the tabulation of fishery observations in 1856. All this was desultory, however, until the reconstituted Board of 1882 stated that 'without further information as to the habits and life history of the food fishes, it would be impossible to submit satisfactory Reports to Parliament, either as to the improvement or as to the regulation of Fisheries.'

England had no fisheries department at all until 1886 and its activities were scarcely worthy of note for many years. Scientific investigation was developed, however, sporadically by certain of the Fishery Committees which were responsible for the control of different parts of the English coast. It was practically dependent on the private interest of a few scientists of note, one or two semi-private biological stations, and the Marine Biological Station of Plymouth whose fine record of work from 1884 onwards is well worthy of mention. The English Marine Biological Association might be regarded as the official advisor to the Government during that period.

In the year 1899 the Swedish Government invited Government representatives from Great Britain, Germany, Denmark and other European countries to meet at Stockholm for the elaboration of a joint scheme of exploration of the seas in the interest of sea fisheries. Out of this arose the *Permanent Council for the Investigation of the Sea* which has instituted many researches into hydrography and marine biology and whose publications are of the greatest value. In these works the shading of so-called pure and applied science into each other is very evident.

Anyone interested must look elsewhere for the history of all these and other organizations. My purpose in this brief account is merely to suggest the atmosphere in which the need for inquiry arose. To a considerable extent this enveloped a demand from one section of fishermen for legislation against another; the conflict of those pursuing one kind of fishing against some method of fishing used by their brethren, which was supposed to be causing depletion. A unifying feeling if present in the fishing fraternity was due to a rooted objection to legislation of any kind on the grounds that it was wrong or useless to interfere. And boards of enquiry had often to admit that they knew little or nothing on which to base the laws.

In these ways, then, our history of Fishery Science commenced 64 years ago. It was a lucky chance that in those happy pre-war years I met at Kiel, and Heligoland, all the German commissioners, Hensen, Brandt, Reinke, Krümmel and Heincke, the members of the very first organized body for the development of fisheries science. Their work was well and truly aimed at the fundamentals.

Suppose, however, one glances through the whole mass of literature which has resulted from the development of the various bodies to which reference has been made—what is the general impression of the condition of Fisheries Science, of its aims and its achievements, of its methods and its requirements? How do we stand in Australia and what attitude should we take to this sort of research? It is to find the answers to these questions that I have set myself in this address.

The first impression made by much perusal of Government and other documents is that, considering the amount of research which has been conducted under the auspices of fishery commissions, a considerable amount of energy has been wasted on non-essential work. I must be careful about this criticism because no one realizes better than myself how exceedingly difficult it is to draw the line between pure and applied science. This was recognized at the very initiation of the United States Fish Commission when it was asserted that the life histories of the fish could not be complete without a thorough knowledge of their associates in the sea, especially of those which form the prey of, or which prey upon, the fish population. Unfortunately fishermen, pseudo-experts and politicians have all been far too ready to step in with criticism somewhat similar to that of mine above—albeit far more embracing, and with nothing to support it.

Fisheries science involves very adequate knowledge of many cognate sciences. To understand the phenomena of growth, migration and reproduction of any particular species of fish, necessitates the co-operation of biologists, physicists, chemists and hydrographers. It is quite easy to understand why the fisherman or the man in the street cannot see the necessity for investigating, say, the minute floating life (the plankton) of the sea so long as he is altogether ignorant of the elementary facts about such work. Yet, whilst impatient of general criticisms, and of the lack of understanding on the part of these people, I feel bound to stress the fact that *experiment* has lagged far too much behind *description* in zoology. Elaborate descriptive catalogues of starfish and medusae *may* at some time play a part in our control or understanding of the marine environment, but the enormous output of purely taxonomic zoology has overshadowed other work of fundamental importance. Fortunately there is a new spirit in zoological science amongst the younger school today.

Sea fishery does not at present bear any resemblance to Agriculture for it only represents the harvesting. And the first prime essential, which has been recognized by Governments everywhere—even by the Governments of Australian States—is that Fisheries must be conserved. That word '*con*served' I shall suggest means something a little different from the more frequent term '*pre*served'. I suggest that it implies that whilst fishing shall take place and full use be made of the natural produce of the sea, it should be regulated in such manner that the natural yield is at least upheld. If methods of increasing the yield can be discovered, so much the better.

And here I may suggest that the fishing industry above all others requires the attention of Government. It is most akin to agriculture but its claim for help is even greater, for the farmer may at least hope to own his land, and what he does with it does result in benefit, (or the converse), to himself, as well as perhaps to the country. But the sea fishermen have no claim either to the sea floors, or the surface waters. Force of circumstance in the past has driven the hardy fisher folk of the northern hemisphere to invent their own gear and even to explore remote icy seas to obtain their profits. But in a country like Australia (where there is no time for this century-long growing-up process, and the slow evolution of older populations), I can scarcely visualize a public company spending large sums on the exploration of new fishing grounds when they know that the results are going to be available to anyone else who likes to use them.

THE METHODS OF FISHERIES SCIENCE

Biometrical methods

As I have indicated above, the first step in the application of science to fisheries is the obtaining of knowledge of the fishery stock and something definite about its productivity. Starting off from this point we are at once faced with the following questions when taking stock of the fish production of the sea.

(1) Is there over-fishing?

(2) If over-fishing is taking place how can it be avoided?

Round about these two questions revolve many different branches of Fisheries science.

In order to answer the first question, methods must be devised to determine:—

(*a*) Some idea of the natural resources of the region of the sea under consideration and the proportion of the fish caught to the natural production in the same time.

(*b*) Whether *natural fluctuations* in yield occur quite apart from anything which may be due to human influence, and what may be the relative force of nature as compared with human interference.

(*c*) Whether definite reduction in the number in the sea of one type of fish—either species or size class—is really a bad feature.

(It has been said, for example, that overfishing of large sizes may result in more fish food and consequently faster growth and greater production on the part of the smaller sizes.)

The second question set out above involves firstly the problems of fish hatching and fish-rearing. Is it possible to perform such operations commercially and can over-fishing be balanced by such means? Another possibility of enrichment also exists by the transplantation of small fish from one area relatively rich in small fish but poor in food supplies to another area rich in the latter but removed from the breeding grounds of the species. These lines of investigation bring along in their train the following necessary studies:

(1) The acquirement of a full knowledge of the life histories of the species of commercial fish involved, from the egg stage to the adult, their feeding and breeding habits, and their migrations.

(2) A knowledge of the marine environment—its physical, chemical, and biological characteristics.

The difficulties of the biological problems are extremely great, however, and the fishermen and others interested must realize this at the outset and properly evaluate the work of the scientist—an attitude which is rare, except possibly in Japan and the United States. It has taken a very considerable expenditure to date to determine the exact habits of the Australian blowflies and the best methods of restricting them, yet unfortunately with little practical success so far as the latter object is concerned. Living things are not so easy to control or remodel as machines, or articles of wood and iron. And living things in the sea present the additional difficulty that usually they cannot be seen until caught. Their very capture involves difficulties and increased expense. The area of the earth involved in sea fisheries brings further trouble—fisheries are not usually tied down to a small district; and eggs spawned in one region may drift far and grow up in another quite distant place.

There is no doubt that the first step in the general investigation of a fishery involves the institution of methods for capturing fair samples of fish from the sea and the establishment of statistical methods for dealing with these samples. By the application of the correct methods, information can and should be obtained regarding (1) the number of fish of any particular species in a catch of definite duration—time and locality being accurately noted; (2) weight of fish; (3) lengths of fish for age determinations, also scale samples; (4) sex and degree of development (to be correlated with length, age, and season); (5) contents of alimentary canal.

Fishery statistics devised for operating on such information are, however, not by any means simple. Commercial statistics may, if taken honestly, supply some valuable information indicative of the fluctuations in the sea. For this purpose, however, information is necessary regarding the source of the captures (which very often trawling captains or owners refuse to divulge) *and the duration of the hauls,* so that eventually one can determine a most important figure—the catch per a unit of time—sometimes set out as the catch per day's absence, better and more definitely worked out as the catch per 100 hours fishing.

For example, in 1924 the catches of English trawlers worked out as follows for 100 hours of trawling:

In the North Sea 122 cwt.; in the English Channel 101 cwt.; South of Ireland 246 cwt.; but the Barents Sea gave 890 cwt. and Iceland 1027 cwt. New South Wales trawlers have never reached such high figures as are reported for the Barents Sea and Iceland, but occupy an intermediate position, with 430 cwt. in 1919, 443 cwt. in 1921, and 470 cwt. (probably the highest average reached) in 1922. Unfortunately the present figures which will be referred to later give yields which are only 290 cwts. or thereabouts.

A serious difficulty in addition to those raised above is that in any long period of yearly comparisons the catch per 100 hours may be invalidated owing to changes in types of fishing gear or methods of fishing. Yet it is these long series of statistics which are valuable. The statistics of the northern hemisphere which go back some years before the war are not altogether comparable with ease because the types of fishing gear have changed. This difficulty may be allowed for with care. For the greatest accuracy there is no possibility of working other than with special research vessels whose gear can be controlled for the special purposes in view, but this makes investigation costly and limited. There has been considerable difficulty in obtaining fishery statistics which can be utilized for the purposes indicated above and from which observers can deduce all that science has shown possible. It is obvious that the taking of length measurements may often necessitate scientists or trained observers working at sea on research or commercial vessels. The catches brought to market by commercial vessels do not even represent fair samples of the catch taken—all small fish having been thrown overboard.

At the Pan Pacific Conference held in Honolulu in August 1920 the Government of Australia (with Japan, New Zealand, Canada, U.S.A. and Hawaii) was recommended to collect systematic statistics of the fisheries and publish them annually. Nothing has been done and fourteen very important years have gone since then. At present we lack valuable fundamental information as a result of this for the Australian statistics indicate merely the amount and value of fish landed. And they do not even allow any attempt at discovering the catch per 100 hours fishing or the catch per day's absence from port.

Now let us see what biometrical work may accomplish. The statistics of the Plaice Fishery of the North Sea form probably one of the best examples the world can provide of the difficulties in the interpretation of fishery statistics. It is worth while, therefore, to utilize this example as an illustration.

From 1906-1913 there was every indication that the North Sea was being harvested to the fullest extent. 671 *first class* fishing boats were on the register of Grimsby alone in 1914, and taking Grimsby, Lowestoft, Hull and Yarmouth together the number was 1883. All these boats did not fish in the North Sea but we have not counted the Scandinavian, French, German and other vessels which did. The total yield of plaice per day's fishing per boat averaged about 2·1 to 2·5 cwt. and although the fullest statistics were not available for early years there seems no doubt that there had been a very big drop in the day's catch per vessel.

Now the war years effectively closed the North Sea to fishing—a close season was brought into being that no amount of peaceful international agreement could have accomplished. The fish were left alone on their banks except for the occasional explosion of mines and depth charges. At the end of the war—1919—the first trawlers to get to work captured 4·5 cwt. of plaice per day's fishing, nearly double the pre-war amount, so the change was *easily* noticeable. Moreover it did not require any statistical evidence to show that hauls of unusually large fish were being easily obtained.

The figures of the statisticians showed, however, that this did not mean that the numbers of all sizes of plaice had increased. Actually there was a reduction in the proportion of the small fish present in the catches. Thus, figures representing the relations of large, medium, and small, run as follows:—

	Large	*Medium*	*Small*
1913	5	8	10
1919	9	13	2
1920	13	12	5
1921	6	11	6
1924	2	5	13

A scientific explanation was put forward to explain these surprising figures. The possibility of making such an explanation was, however, entirely due to the previous work of certain investigators—in particular Heincke, on the age determination and rate of growth of the species of fish in question. I shall digress for a moment and consider the technique of such research, which forms an important branch of fishery science.

From the beginning of the more serious scientific efforts to determine the productivity of any area in fish and the results of man's attack on such an area, it has been obvious that no accurate solution to the problems could be hoped for without information regarding the ages of the fish of different sizes caught, and also of their rate of growth.

One of the earliest successful methods of age determination was invented by the Danish scientist, C. G. J. Petersen. It is a statistical method dependent upon the breeding season of the fishes for which it is used, being limited to a more or less short period of the year.

If the lengths of a large number of individuals of the species in question are taken and tabulated, they will be found to fall into distinct groups. A curve depicting the lengths may be a many peaked curve, each peak being the mode of frequency of a class. And the *difference* in length between the mode of each class represents the increase in growth which has taken place in a year. Figure 1 represents such a curve for the Tiger Flathead taken by trawlers off the coast of New South Wales between the 12th August and the 2nd October, 1930.[1] Peaks occur at 24, 32-33, and 42 centimetres.

Unfortunately, where this method has been utilized very considerably it has been shown that it is only applicable to the younger and more actively growing year groups of fish. It is also open to other errors since the rate of growth may be very seriously influenced by local environments (there may even be local races which normally differ in character), by favourable conditions, by plentiful nutriment or the converse, starvation. The method is, however, very useful especially when it can be checked by other means.

There is another method of age determination which depends upon the rings of growth which occur on scales and other skeletal features, particularly on the auditory ossicles. The first to show that scales could be utilized accurately in this way was Hoffbauer using the Carp, and Thomson of Plymouth, with the Haddock, 1902. The otoliths were utilized by Reibisch in 1898, and then Heincke showed that almost all the bones of teleost fish showed definite rings of growth which could be clearly associated with annually recurring different seasons—the alternation of summer and winter—quick growing and slow growing periods of the year. If it can be shown that one ring is added per year and the age of the fish at the deposition of the first ring is known, the age of any fish of the species should be determinable by scale or bone examinations.

This method has been proved reasonably accurate in many cases by comparing the results of scale readings with the results of the Petersen length technique. The simplest demonstration of course is that by making direct observations on fish which are cultivated in ponds or aquaria. Another important method of checking scale readings is one which can be associated with the marking of live fish in connexion with the study of migration, etc.

In such marking experiments, fish tabbed with characteristic 'badges' are set free, after the length of the fish and character of the scales have been noted. If such fish are captured, say a year or more later, there should be additional scale rings to correspond with the increased age. The increase in length will give directly the rate of growth. Such marked fish which have been recaptured have demonstrated sufficiently well the accuracy and usefulness of scale readings.

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[1] During the year 1930-31 35,000 Tiger Flathead *(Neoplatycephalus macrodon)* were measured by my colleague, Mr. A. N. Colefax, B.Sc., on trawler voyages.

Up to date, however, most of the scale reading methods have been used in the cooler temperate seas and whilst they are clearly applicable to fish of Tasmanian waters (I have had scales of Trumpeter and other species sent me by the late Mr. Clive Lord) and I have reason to believe are probably applicable to certain fish species of New South Wales waters, they may be altogether uncertain in our more tropical waters.

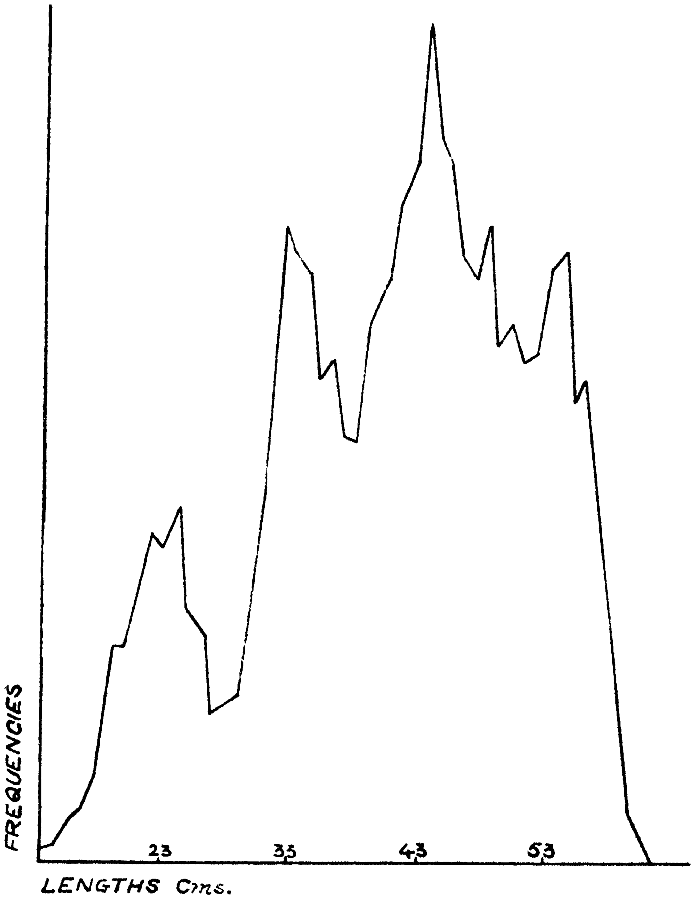

Fig. 1.—Curve depicting frequencies of Tiger Flathead of lengths between 14 and 62 cms. taken on three cruises during Sept.-Oct., 1931. (From data of A. Colefax).

We can now return to our North Sea example of fishery statistics. The results of scale readings not only showed that the large post-war plaice were *old* fish, but that *the smaller sized fish did not correspond in age to pre-war fish of the same length. They were older.* In other words the post-war plaice were growing more slowly than the pre-war plaice.

The average lengths and ages for pre- and post-war plaice are given by Fr. Heincke and Ad. Buckmann as follows:—

Age Groups	I	II	III	IV	V	VI	VII
Average Length in Centimetres—							
1905-6	15	19	23	26	30	32	38
1922	14	16	19	22	25	29	32

An explanation of the above figures was offered as follows:[1]

As a result of the war-time cessation in fishing, large numbers of plaice increased in age and consequently in size. The result of this was a crowding of young fish on the bottom in certain areas with a resultant diminution in the rate of growth—possibly through reduction in the food supply available. We might regard the North Sea as having thus returned (more or less) to the original condition of virgin grounds.

The first result of the discoveries given above was that the German experts, and certain English workers, regarded the whole matter as an absolute proof of the need for restriction of fishing in the North Sea and evidence of the necessity for international regulation. Plans for such were put forward.

There were some, however, who interpreted the figures otherwise. The late Professor James Johnstone of Liverpool, for example, claimed that in the Irish Sea the variability in size and abundance of plaice during the years 1892-1920 was something that happened of itself—'Quite apart from the influence of the fishing fleets.' Throughout the period there was good evidence of a natural fluctuation in the abundance of plaice, some series of years being good, while others were relatively bad.

If this explanation were applied to the North Sea we should have to believe that the increase of plaice during the war years was *just* a coincidence and little or nothing more. Those who were most familiar with the North Sea did not accept the probability of such a coincidence.

The next step to be noted was a remarkable falling off in the plaice catches in the North Sea in the successive post war years 1920-23. The war-time accumulation of fish seemed to be removed in an amazingly short time. It could not be explained away simply by renewed overfishing. So Borley and Thursby-Pelham in 1924[1] found themselves compelled to state—

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[1] See H. M. Kyle. 'Die Statistik der Seefischerei Nord-Europas' *Handbuch der See-Fischerei Nord-Europas.* Bd x. Heft. 4. 1928.

'that causes due to natural conditions must also have been at work. The acceptance of the proposition that both human and natural agencies are at work is of the greatest importance. Had the natural causes alone appeared responsible, the regulation of the fishery could not hope materially to influence the prosperity of the fishery. Had the reverse been the case, well-planned remedial measures could have produced their effect without hindrance. If the conclusion here reached be accepted, it follows that in part the industry must abide in patience the vicissitudes due to natural causes, but that there is a wide margin in which measures properly based on the facts of the life history of the fish and the knowledge of the destruction caused in fishing should have their reward.'

We have in fact reached a point of the greatest importance after long years of statistical work—the certain evidence that a scientific survey of fisheries must recognize and study the natural fluctuations in abundance which are now known to be characteristic of fish populations. An amazing amount of fishery research today is concerned with these natural fluctuations. In fact this study represents the front of modern fishery research.

This, however, is not all that may be deduced from the example we have chosen—North Sea plaice fishery statistics. We have seen that one school has demanded protection of the region from the 'over-fishing' that is assumed to be taking place. Naturally there is opposition from fishery interests. There is also disagreement on the scientific side. The most desirable treatment of any fishery area is shown to be anything but the simple problem in view at first. Just as on land there may be such a thing as overstocking.

We may aim at the production of a large number of large fish. We may aim at the greatest propagation of fish flesh in the shortest period of time.

The two things are entirely different. As Johnstone pointed out—what the industry wants is fish of a certain range of sizes—if such fish decrease in numbers the productivity of a fishery region is said to have decreased no matter how the smaller fish may have been affected.

The facts from several quarters now show that there may be a definite connexion between intensity of fishing, rapidity of growth, and the whole general economics of the fishery. The problem becomes, therefore, one of deciding what is the *optimum* amount of fishing that an area can stand.

No fishing at all may result in large numbers of very large breeding fish and slow growing fish of all sizes. (A heavy fishing of such a stock will naturally result in a big falling off in numbers because the large ones will be caught easily and there may not be enough small fish on grounds to renew the stock.)

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[1] *Ministry of Agriculture and Fisheries. Fishery Investigations,* Ser. II. Vol. VII, No. 6, 1924.

Real over-fishing, on the other hand, would be that which so reduced the number of egg-producing adults that the egg production came to be insufficient to keep up the stock. This has actually occurred in certain regions.

Clearly the problem of over-fishing has not become less difficult as a result of the discoveries in marine biology.

The New South Wales trawling industry comes first to the mind as a branch of the Australian fishing industry where variations in the catches are likely to be soon reflected in difficulties of finance. Now it is significant that this industry which only commenced in 1915, has recently been clamorous in its demands for Government exploration of the coast on the grounds of depletion. Putting the matter as shortly as possible—the first trawlers were able to fill up as a result of a 3 or 4 days voyage—often after 30 hours out at sea in the neighbourhood of Sydney. During the past few years the trawlers have had to steam two or more days from Sydney before starting to catch fish. The catch per unit hour, or for 100 hours fishing, has decreased notwithstanding the undoubted increased efficiency of the fishermen. Unfortunately this cannot be determined or checked by the official statistics of the fish landed in Australia. Our present official statistics allow of no deductions of any value. Owing, however, to the existence of old trawler records of the State Fishery days and the courtesy of one trawler company in making available the ships' reports for one year and in allowing one of my colleagues to make over a year's monthly voyages on their vessels, we have some other data. The total catch of Flathead landed in New South Wales for the years 1925-33 is as follows:—

1925	6,366,590	lbs.
1926	8,461,600	,,
1927	10,763,600	,,
1928	11,682,450	,,
1929	15,076,676	,,
1930	13,126,621	,,
1931	11,421,681	,,
1932	11,740,708	,,
1933	9,721,495	,,

It is impossible to say from the above whether the stock of flathead has fluctuated during the eight years, because the official statistics do not state the number of hours fishing each year or the number of trawlers engaged. Our own calculations show, however, that the catches of N.S.W. trawlers in 1919, 1921, and 1922 averaged 4·18, 4·56, and 4·68 cwts. per hour's fishing respectively. Now in 1930 the figure was only 2·97.[1]

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[1] For comparison it may be stated here that from the yearly average of all boats in the Barents Sea the catch per hour's fishing is 8·9 cwts. and for Iceland waters 10·27 cwts. The highest *averages* ever made in N.S.W. waters were 6 cwts. per hour—the *Brolga* in 1922.

There is some evidence, therefore, that a diminution in the available stock of Tiger Flathead has taken place in N.S.W. waters. But not enough, judging from the possibilities outlined above, to make any assured statement possible. The fish may have migrated to new grounds. The falling off may also be the reduction which has been experienced everywhere the world over on working a new and virgin fishing ground. A new equilibrium may be set up which can remain more or less constant according to the influence of natural fluctuations.

There might on the other hand have been over-fishing. We know nothing of the fish stocks of the Australian continental shelf. As I pointed out three years ago the present New South Wales grounds only equal the area of the Irish Sea and we have removed from them in one year four times the quantity obtained from the Irish Sea in a similar time. Anyway, whilst it is now realized that natural fluctuations with rhythms often extending over periods of years are characteristic of fish stocks, and are of fundamental importance in any application of science, so is it realized that the old conceptions of an infinite fecundity of the sea are out of date. The situation discovered in our waters is important enough to indicate that statistical work is very necessary, and that it should be combined with any exploration work that may be carried out on new grounds.

Very much to be desired are more biological studies which will give us information regarding the life history and migrations of the Tiger Flathead, its breeding habits and its rate of growth. All this work involves either the use of a research vessel, or the employment of suitable workers on commercial trawlers, combined with the offer by the latter of details of their catches, which are not at present available. It should be easy by tactful agreement for the latter to be made possible especially since there should be no reason why any information obtained during this work, should be divulged or made public in any way until a year had elapsed. But the Tiger Flathead is only one example of the need for more information regarding our commercially valuable fish.

Let us now return to another aspect of our fishery research which is intimately connected with that we have just touched upon. You have seen from Text fig. 1 that some attempt has been made to apply the system of age determination by length measurements to a New South Wales fish (the Tiger Flathead).

This work was carried out by my colleague Mr. A. N. Colefax, B.Sc. (see Linn. Soc. N.S.W. Vol. 59, 1934) in connexion with a study of our most important trawled fish. A considerable amount of information was gained but unfortunately there has been no possible way of following it all up. The data provides the nucleus for future investigation. Means will have to be provided for capturing the smaller flathead. The life history of the fish between the egg and the smallest stage captured will have to be followed

The significance of the ability to recognize the age groups of fish is brought home by discoveries which may be said to rank amongst some of the most important of fishery science up to date. Both in America and Europe where elaborate statistical investigations have been carried out, it has been found that the natural fluctuations which are now recognized as highly characteristic of the fish stocks of the sea, are bound up with variations in the number of fish present belonging to some particular year group or another. For example, the application of the methods we have described has shown that in the great herring catches of any particularly good year the bulk of the fish caught belonged to a definite year group, i.e. they were all hatched years before in what was either a singularly good reproductive year or one from which an unusual number of fish had survived and developed.

Such a prevalent age group may indeed form the bulk of the valuable herring in the shoals of several successive years (see Text fig. 2). Thus the success of any particular year's herring fisheries may be entirely due to the attainment of maturity of some long antecedent very successful year of reproduction. The discovery of these facts is having two consequences.

(1) It is making it possible to forecast successful fisheries a year or even more beforehand by following the gradual growth and the attainment of commercial size of some successful year class. This forecast may eventually include the date a profitable fishing might be expected to commence, the expected quality of the catches and the estimated yield. It is the *uncertainty* and *variation* in yield in pelagic fishing which is usually most serious to both fishermen and merchants. Removal of a little of this uncertainty would be of the highest value.

(2) It has shown that one of the most important causes of fluctuation in any fish stock is due to causes which operated years before when a breeding season was a success or a failure. It has thus given us a clue to a new line of investigation.

Possibly (nay probably) the causes which determine the success of the breeding season of a species of marine fish may be always beyond our control. At present, however, we do not know what they are and it is certainly worth-while trying to find out. The most favoured assumption is that the environmental conditions prevailing during the period that the eggs are hatching out and during the immediately following weeks are of paramount importance. There is little doubt that this is one of the most hazardous periods in the life history of a marine fish and if the planktonic conditions at the time the young larva is hatched are unfavourable for it, there may be no food suitable for these delicate stages.

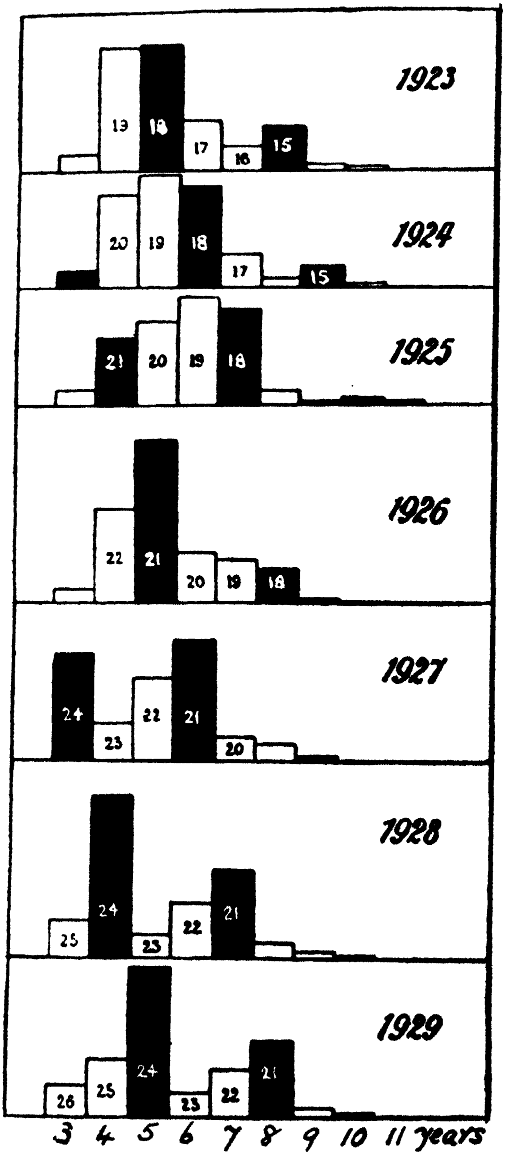

Fig. 2.—The fluctuations in the composition and abundance of herring in the East Anglian fishery from 1923 to 1929.

The figures at the bottom indicate the age of the fish in each year group. The height of the columns indicates the abundance in the catches of the particular year group, and the figure on the columns indicates year of hatching. "Black" columns represent successful year groups. (From W. G. Hodgson).

STUDIES OF LIFE HISTORIES

At the present moment we know next to nothing about the eggs or the larval stages of our Australian marine fish. There is a gap in our knowledge that must be filled up and here let me describe some of our own work in following life histories which has in its small way resulted already in a considerable success during the past few years.

The eggs of most marine fish of commercial importance are pelagic, that is to say they float in the sea. Herring eggs are exceptional, being laid on the bottom on various objects (and of course the reproductive habits of sharks and rays, fishes which sometimes come also within the purview of commercial significance, are very different from the more important teleost fishes.) In order to recognize for the first time the species of the tiny floating eggs of teleost fishes, two methods are available.

A particular fish species may be kept in numbers in ponds attached to a fish hatchery and the eggs, after extrusion from the mature females (and subsequent fertilization) may be scooped up from the water in fine silk nets, placed in hatching boxes and the development gradually followed. In this way there is no doubt at the outset that the eggs belong to the species of fish which we have in the pond. The egg may be examined and the features referred to below noted. If hatching and culture for a time are successful, the different stages from the egg until the definite adult form is reached, may all be examined and illustrated. It should then be possible on future occasions to recognize these eggs or larvae when caught at sea.

A variation of this method is to take the mature fish from a pond or aquarium tank and actually squeeze out the ripe eggs from the female and the ripe sperm from the male and conduct the fertilization in glass vessels. The whole sequence of stages can then be followed as before. This method can be easily adapted for use on board commercial fishing craft and the following simple device was invented and used successfully by us on N.S.W. trawlers. It consists of a small cylinder of celluloid with windows, these windows and the ends are covered with bolting silk. Eggs taken from mature fish captured by the trawler are introduced into the cylinder, the silk replaced and the whole thing immersed in a large bucket or other tank of sea-water which is conveniently changed or kept refilled as required. The motion of the ship keeps the submerged but floating cage, with its eggs, in constant movement, and at least the egg stages and possibly early larvae can be obtained in this way.

The main difficulty about the above methods is the obtaining of mature fish or of keeping members of both sexes until mature. Still, this is frequently accomplished, for it is the practical method of such marine fish hatcheries as are in existence.

The second method applies to the fish eggs which are captured floating in the sea water and which are taken in plankton nets sometimes in abundance, sometimes in isolated numbers.

Hints as to the possible family of fish to which the eggs belong may be obtained by reference to the known fish eggs of other parts of the world. For example, it is common in the herring group (note that although the herring lays its eggs on the sea bottom, its near relatives the sprats, pilchards, &c. have typical floating eggs), for the egg yolk to be divided up into segments. The eggs of the anchovy are oval (the yolk is also segmented here.)

Now if the planktonic fishery for eggs and larvae is continued on successive days for a period, there is a fair chance that successive stages in the life history may be captured. The following example will illustrate the method. During the months of June, July, and August of the three years 1931, 1932, and 1933, numerous eggs were captured off Sydney which were characterized by a wide perivitelline space and a segmented yolk (Text fig. 3). The general resemblance suggested that the egg belonged to a member of the herring group (Clupeidae). But no less than six different species having eggs of this type were found by Delsman off Batavia. It was necessary, therefore, to have further evidence before closer identification could be made. In successive catches in each year eggs had been obtained at different stages of development and we had also taken newly hatched larvae. In 1933 partly as a result of a special effort to settle this particular question, a more concentrated search was conducted for the later and later larvae and as a result we were successful in getting stage after stage which we could link together until finally the size of 28 mm. was reached.

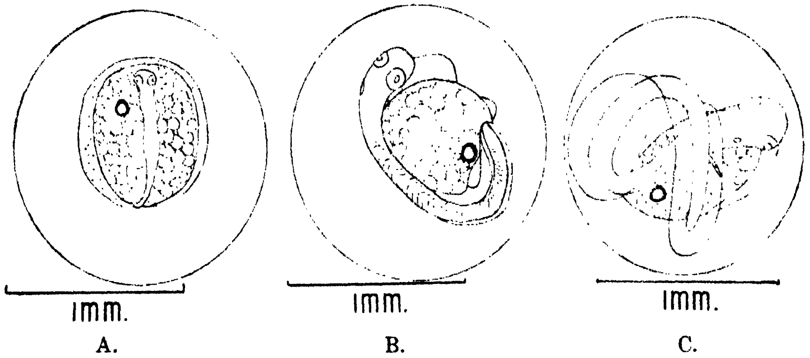

Fig. 3.—Egg of *Sardinia neopilchardus*, Steindachner, diameter 1·4 mm.

A—Early stage of development. B—Later stage of development.
C—Ready for hatching. (From Dakin and Colefax.)

[Block lent by courtesy of The Trustees of the Australian Museum.]

It was not until we had this size that we could be absolutely certain that we were dealing with the Australian pilchard (*Sardinia neopilchardus* Steindachner) but at this size the dorsal and other fins, the general form, the number of vertebrae, left no doubt of the identification. This meant, of course, that for all time we could recognize the eggs or any other early stage of this species if met with in our nets. It also meant the recognition of the breeding season and breeding grounds of the Australian pilchard, at least off the New South Wales Coast, and judging from the number of eggs present in the net, it suggested that the pilchard adults were present in large numbers. Up to the present, however, there has been practically no pelagic fishery around the Australian Coast. The herring family which probably provides the greatest sea wealth in the form of fish, remains almost untouched in Australian waters. California in 1929 took 857,000,000 lbs. of fish from the sea and of this 652,000,000 lbs. were sardines to be used for canning or for reduction purposes (oil and fish meal). The total Australian landings of fish for 1931 were only *62,969,760 lbs.* It is easy to see, therefore, why the exploration of our seas in regard to pelagic fishes is a very desirable experiment.

The search for fish eggs at sea is only part of what is known as Plankton Research. I shall return to other sides of this investigation later.

There is not very much available for purposes of comparison or recognition in fish eggs but, as Ehrenbaum points out, the size, the presence of oil globules, the character of the yolk, the shape, the perivitelline space, the colour, are all features which can be noted. In this respect preservation causes changes all round. It would be advisable to measure considerable numbers of fresh eggs of any particular type in order to determine the range of variability. In respect of the larvae—the shape, the number of the fin rays in particular, and also the number of vertebrae, are important. In addition, the colour, pigmentation, and size, should be noted.

Plankton Studies and the Life History of the Australian Pencid Prawns

There is another life history study in which our plankton work has played a part; it is published for the first time here. On various warmer parts of the Australian coast there is a valuable industry in the fishery for prawns. In New South Wales waters it has averaged about £38,000 during the last ten years. The year 1931 was, however, a peak year. The value reached £76,871 and the quantity obtained was 1,537,420 lbs. This yield is much more startling when it is realized that all this crustacean material came from river estuaries or lagoon-like lakes of relatively little depth which are open to the sea by very narrow and shallow channels (Lake Illawarra and Tuggerah Lakes) and this is in addition to heavy fish yields from the same waters. The prawn fishery is not so important in Victoria, the annual catch being probably little more than 10,000 lbs. from the Lakes of Gippsland. Prawns of the same family are found in the Swan River at Perth but the fishery is only worth about £1200 annually. The Report of the Chief Inspector of Fisheries for Queensland for 1932-33 merely mentions prawns as scarce on the Brisbane market. They should be abundant, however, on the Queensland coast.

Now these commercial prawns of Perth, Gippsland Lakes, Queensland, and above all, of New South Wales waters belong to a Crustacean group—the Peneidae—members of which differ markedly in their mode of reproduction from those of all other groups of the Crustacean order Decapoda. It should be noted in passing that the commercial prawns and shrimps of England and Northern Europe which look superficially very similar to ours, belong to an entirely different group. The Peneid prawns are characteristic of warmer seas. They are elsewhere of commercial importance in Mediterranean countries, in the Southern United States, India, Malaya, and Japan.

Our best known species in New South Wales waters are the King prawn, *(Peneus plebejus)*, and the School prawn *(Penaeopsis macleayi)*. The former is known from Queensland down to the South Coast of New South Wales and occurs again in Western Australia. The school prawn is also known over the whole coast of New South Wales. A third species *(Penaeopsis monoceros)*, less well known on the Eastern Coast of Australia is common again in the Swan River at Perth and has a very wide range being one of the commonest of the Indian prawns and even turning up at Japan and the Philippines.

It is characteristic of our Australian crayfishes and crabs as well as of the shrimps and prawns, lobsters and crabs of Great Britain that the females carry the extruded and fertilized eggs under the abdomen until they hatch out as highly developed larvae. The Peneid life history is very different. The females shed their tiny eggs from the ovaries direct into the sea where they float during their short development until a primitive larval form—the *nauplius*—hatches out. Although this has been known to zoologists for many years it seems to have been singularly unfamiliar even to fishery experts of the countries where Peneid prawns are of commercial importance. In fact little or nothing has been said in their reports about the habits of these prawns notwithstanding the puzzle of their origin.

In New South Wales the problem of the life history of the common prawns aroused my curiosity at once—partly because I had been fortunate enough to catch the eggs and early larval stages of one species in the Swan River, W.A. many years ago. But the stimulus was great enough without this, because to many hundreds of fishermen the prawn was something of a mystery. This was the case at Lake Illawarra (and the same applied to Tuggerah

Lake and Port Jackson harbour with the Parramatta River entering it). During the winter few or no prawns can be taken with nets, and those captured are usually small. There comes a time during the spring when the king prawns become catchable in the Lakes and generally they are first taken at that end of the lake farthest away from the sea and are rather small. During the early summer larger specimens are captured, and then amazing 'outflows' or 'migrations' to the sea take place on dark nights. I have seen two or three of these 'runs' take place. Visitors at the lake entrance, young and old, take hurricane lamps or electric torches, kerosene tins, buckets and hand nets. They flock down to the entrance which connects the lake with the sea, where at low water you can stand with the outstreaming current only up to the knees. Soon there is a semicircle of closely packed people with their lights. It is now, shall we say 7.30 p.m. The water running out to sea is dark blue and clear under the lamps. There are no signs of life except for an occasional crab. The crowd waits. Suddenly someone near the lake cries out 'here they come,' and as suddenly as that, the prawns arrive. Swimming actively, the big prawns come like an army and are rapidly caught as they try to pass by until the buckets are half full and the hunters drift away homeward one by one. Fishermen with nets are at work in the lake itself. A set net at the entrance—naturally not allowed—would make an amazing capture. The moon is quite sufficient to stop the migration which ceases for a number of days at full moon unless the nights are very cloudy.

Every year this story is repeated and millions of large king prawns have been observed leaving the lakes for the sea. But no one ever saw the prawns entering the lakes or estuaries, and since the fishermen looked for eggs on the abdomen as indicative of breeding females they never found any of the latter. Knowing the life history and reproductive habits we naturally adopted the method of dissecting the large females to determine the state of maturity—but curiously enough in most cases there were only mere traces of reproductive organs. Only two theories could be put forward to explain the situation.

(1) The king prawns bred in the lakes and estuaries—this would easily explain the constant supply always moving out to sea and never coming in. But why then did the large prawns go out to sea in such definite masses? And why did one never find a really mature prawn in the lakes? Did they hide away in this condition? One would have to assume too, that the big prawns caught leaving the lake had just spawned in order to account for their small gonads.

(2) The other theory was that the king prawns bred in the ocean and never in the lakes or estuaries and that the lake supplies, enormous as they were, resulted from an early inshore migration of the young at such a small stage that they were never seen by the fishermen. On this theory the lakes would be regarded as specially favourable growing grounds where the prawns gradually increased

in size on the rich food supplies. Finally having attained large size they would leave for the sea in regular armies for their first breeding season. Our largest prawns caught in the lakes and estuaries were, according to this theory, still immature.

We set ourselves to prove one or other of these theories. Prawns were obtained from all the estuaries of New South Wales and at all seasons of the year and dissected for examination of the reproductive organs. And always (with the exception of one species to be referred to later) the reproductive organs were undeveloped. Only when we obtained a few outsized king prawns from near the entrance of Port Jackson in late summer did we find the gonads well developed. But *always* when we obtained large king prawns from the ocean (captured by trawling) the gonads were well developed (see Plate II).

At this stage in our investigation the plankton catches came to the rescue. From the beginning of March the characteristic eggs of the Peneid prawns with the developing nauplius larvae were taken out at sea in our plankton nets. Later on the young stages were also captured. And the converse is true, no eggs of the king prawns were ever taken in inshore waters. I think the life history of the school prawns is exactly the same. The breeding season of the king prawns in the ocean probably extends over at least six months for we have found king prawns at sea developing maturity as late as September.

During the later months of the year in late spring and summer the young of the prawns must stream into the estuaries and lakes, soon to take up their normal habits and grow up.

And now we come to the further surprise. The sizes of the prawns captured by us both at Lake Illawarra and elsewhere, leads indubitably to the conclusion that, with the exception of the very large ones, they are all less than a year old. The largest prawns leaving Lake Illawarra in the summer (size 18 cms.) are not less than 13 months old and no older than 18 months. Our work indicates that the king prawn breeds at about the age of 18 months and the females are then about 21 cms. in size or even more. The rapid growth and attainment of the breeding season in such a short period is not common in commercial marine products. What happens to the prawns in the sea is a very interesting question about which we know absolutely nothing. No studies on the complete life history of Peneid prawns had been made anywhere in the world until recently when the United States Bureau of Fisheries took the matter up. In a recent paper it is stated that probably their prawns never breed again after their first season. If this is the case with our Australian species it will be realised that once again pure science has information of very considerable importance in regard to the proper regulation of a valuable fishery.

I mentioned that there was one exception to the above life history. It is possible to find the adults of *Penaeopsis monoceros* with mature reproductive organs in the inshore waters and once I found their eggs floating in the Swan River at Perth. This species breeds during the late summer months. Curiously enough they have been regarded as school prawns by most of the New South Wales prawn fishers—but school prawns which were not quite as they ought to be. In some districts they are called Greasy Backs.

The Hatching and Rearing of Marine Fish

In my introduction I pointed out that one possible way of increasing the stock of marine fish was by 'artificial' hatching—the rearing of eggs and younger stages in fish hatcheries. Is this feasible and with what possibility of success?

It is difficult to say when the first efforts in fish culture were carried out. The Romans were probably preceded by the Chinese in this respect—the fish being fresh-water fish. So far as we know, however, the eggs were laid by the fish and carefully collected by the 'nurserymen'.

In the fifteenth century (1420) a certain Dom Pinchon cultivated trout at the abbey of Reome near Montbard in France. In 1758 Lieutenant Jacobi of Hoenhausen wrote a manuscript describing how he squeezed the eggs from ripe females and the milt from the males and fertilized the eggs. Artificial fecundation was being practised by the Swiss with trout in 1772 although the function of spermatozoa was not even known at this time. Then this artificial fecundation seems to have been forgotten until it was re-discovered by a simple fisherman, Remy, of Bresse (Vosges). Remy's methods became known to the scientific world through Professor de Quatrefages in 1849. From this time on a great development of fish hatching took place, particularly in France and Germany. When the United States Fisheries Commission was instituted the possibility of counteracting depletion by hatching and rearing was visualized at the outset and such was the vigour with which this side of fisheries technology was pursued, that already in 1872 the United States had gone further almost than anyone else. Since then the United States has led the world in this matter and if one wishes to follow up the types of technique involved, reference should be made to the publications of the United States Bureau of Fisheries. There is, however, an important side of this question for our consideration. The success of fish hatching is certain in so far as it concerns fresh water fish like the carp and its relatives, the trout, the salmon and others. It is quite another matter when one regards the vast fisheries of the sea. The eggs of the trout are about as large as peas—there is an abundance of yolk, the young larvae are hardy and their early life is spent in circumscribed areas which can easily be imitated or found in other places.

One of the most dramatic successes in fish hatching was that of the introduction of the Shad from the Atlantic Coast of the United States (its natural home) to the Pacific Ocean, and its spread and development in the waters of Canada as well as California. This, a fish of the herring family, is also a fish of the anadromous type, i.e. it spends some time in the sea but, like the salmon, leaves it and ascends rivers, to spawn in fresh water. Right at the very beginning of the American Government's attention to fishery investigation, i.e. in 1871, a consignment of shad fry was conveyed from the Atlantic coast (Hudson River) to the Sacramento River, California. This was repeated in 1873 and other years. Adult fish began to turn up within a few years and by 1876 they were getting common in the river where they had been set free. By 1895 the shad fishery of California was of extreme importance to the State and the fish had spread north to the rivers of the Canadian Coast. The species constituted the sixth largest fishery of Northern California in 1928.

This example shows what may be done in the way of introducing a fish to a new area, but it is scarcely a testimonial to the hatching of eggs of typical marine fishes. The spread of the shad in the Pacific may have been due to the occurrence of particularly favourable conditions there. Up to date even the artificial hatching of shad in the Pacific coast rivers has not been able to increase the yield sufficiently to balance human depredation or natural fluctuation.

There is singularly little evidence, then, of success in marine fish hatching. No practical results so far as I know can be put up to support the United States hatcheries for cod, although it must be noted that these are regularly continued; nothing that would be accounted beyond criticism has been put forward to support the British or Norwegian sea-fish hatcheries.

Fifty-eight years ago the United States Fisheries Commissioner said: 'Here the fish culturalist comes in with the proposition "that it is cheaper to make fish so plenty by artificial means, that every fisherman may take all he can catch, than to enforce a code of protection laws." The Salmon rivers of the Pacific slope, and the Shad rivers of the East and the Whitefish fisheries of the lakes are now so thoroughly under control by the fish culturalist that it is doubtful if anyone will venture to contradict his assertion. The question now is whether he can extend his domain to other species'.

That this was an optimistic view is evident from the fact that eight years ago the Assistant in charge of Scientific Enquiry of the United States Fish Commission said that despite 55 years of artificial propagation, the Pacific salmon fishery had declined alarmingly the shad fisheries had declined by 74 per cent. from 1896 to 1923 and the whitefish fisheries, despite an annual distribution of 409,000,000 eggs and fry, had declined in yield from first place in 1880 to fourth place in 1922. Probably in these cases, all being fish with eggs hatching in fresh waters, the results would have been worse without the aid of the culturalist.

So far as sea-fish culture is concerned the summing up by Knut Dahl in 1909 may still be said to hold good. The majority of fresh-water fish possess relatively large and hardy eggs which are hatched resting on the bottom or glued to objects on the bottom. The period of incubation is long. The young when hatched are active, well developed, and hardy creatures. They can easily be reared, can be kept in thousands in a limited space, and fed and reared at no great cost. On the other hand the areas of the sea are so extensive that hatching operations on a tremendous scale would be necessary in order to 'be capable of influencing the enormous quantities of drifting fry which the open waters (of Northern Europe)[1] have been proved to contain.'

The pelagic eggs of marine fish contrast strikingly with those just referred to. They are small and delicate, the period of incubation in our waters may be only a day or two. And all the hatcheries can do when the young are hatched is to 'hurry these larvae into the sea where for many weeks they lead a pelagic life suspended in the waters and subject to their movements'.

I should like, however, to suggest that the last word has not been said in the matter of sea-fish hatching and I would illustrate my point by reference to a case which is almost unknown in the northern hemisphere and which has lately come under my notice in quite a new aspect.

A few months ago I visited the Pacific island of Nauru, (Australian mandated territory). The island is an old coral islet which has been raised so that its highest point is about 200 feet above sea level. In the centre is what is called the lagoon, probably a remnant of an original lagoon, but now a swampy lake cut off from the sea by high ground and very unlike the typical lagoons of coral atolls. At the time of my visit there had been little or no rain for some months. Notwithstanding this, the salinity of the water of the lagoon (which was partially dried up) was only 9 per thousand. The lagoon area is divided up into little ponds and these are crowded with a species of fish, *Chanos chanos* (known to the natives as *Ibya*). The average length of the specimens I saw caught was about 15-18 inches but they grow much larger. These fish are cultivated fish and the lagoon ponds remind one of carp ponds in Europe—highly productive areas of water.

Now the story of the Ibya fishery of Nauru is a surprising one. At a certain time of the year the natives of the lagoon district go down to the ocean coral reefs and look in the rock pools for tiny fish larvae. According to their description these little fish are only about a quarter of an inch in length and extremely difficult to see. They are fished out with a shallow strainer and placed in very ordinary receptacles in the native huts. Apparently the water is changed at intervals but the whole business is most primitive and I should scarcely imagine that the natives understand much of what they are doing. It is almost an instinct with them. The procedure is something which has been handed down from generation to generation and probably has continued for hundreds of years on the island.

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[1] The same thing will apply in other wide and unrestricted seas.

The tiny fish grow rapidly and after a few weeks when they have reached the size of about 2 cm. they are transferred to an outside pond of small size. They do not receive much further attention and gradually grow up. Two months later they are transferred to the big fish ponds of the lagoon where they gradually reach adult size and are ready when required.

Now there are several remarkable things about this business. In the first place the natives collect the larvae of a marine fish at a stage which, in sea fish hatcheries with other fish species, is set free as too difficult to handle further. In the second place, at this difficult stage they change the fish over from sea water to lagoon water which has a very different salinity and constitution. This of itself is a matter which interests me keenly because the osmotic pressure conditions existing between aquatic animals and their environments have been the subject of my researches extending over twenty years.

But let us follow this matter further. The fish (which incidentally the Europeans on Nauru have regarded as something peculiarly Nauruan) is the so-called Milk Fish, *Chanos chanos* (Forskal), (sometimes called the salmon herring), a sea fish related to the herring and of very wide distribution, ranging indeed from the Red Sea where first recorded, the Indian Ocean (on all coasts), to the Pacific Ocean (noted from the East Indies, Samoa, Society Islands, and as far south indeed as New Zealand and Australia). It often enters the fresh waters of rivers and lakes *although it only spawns in the sea.* It is an ocean fish which approaches land at the breeding season and spawns in shallow bays or on coral reef flats.

A specially interesting feature, however, is that this fish above all others is first in commercial importance in the Philippines where the people have from time immemorial cultivated it and now understand many details of the process.[1]

Actually the culture of the fish is highly characteristic of the Indo-Pacific, and is very ancient in origin. Ponds are made and used in the Hawaiian Islands, in Java, Singapore, Madura, and Formosa. But only in Nauru (and possibly at the Gilbert Islands), so far as I am aware, are the larvae cultivated in brackish water.

According to Delsman the eggs of *Chanos chanos*, (called the *Bandeng* in Java), are pelagic. The breeding fish may reach three feet or more in length and the roe contain over 5,000,000 eggs. But the fish never breeds in the culture ponds. There are two spawning seasons in the year and the larvae are scooped up by men, women, and children from floating entanglements of rope set up along the shores.

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[1] This, by the way, may be of great ethnological importance for it is scarcely likely that the Nauruans have discovered the culture process themselves. I should suggest that it might be evidence of the origin of the Nauruan peoples and might provide evidence that they came from Asia by the Northerly route bringing their habits with them. The early Nauruans probably recognized the fish larvae on the reef shores, having been accustomed elsewhere to looking for them.

No attempt seems to have been made at the Philippines (or Java) to remove the eggs from the adult fish, only the young fry are captured in the water, and this itself is a great industry for they are caught and shipped away to the fish cultivators all over Manilla. They are usually about 10 mm. long when captured and quite transparent.

At the Philippines these larvae, in numbers from 1,500 to 2,000 are placed in a 15-litre jar for transport and handled carefully. The jars are kept filled with clean sea-water. The fish larvae are first placed in a nursery pond and apparently after about two or three weeks they should be 3·0 to 3·5 cm. in length, and are then removed to the ordinary ponds. In the Philippines the larvae feed upon a blue-green algal mat (containing other microscopic plants and animals) which develops at the bottom of the pond, but I shall have to omit many of the interesting details which are known of this fish culture in the places where it is carried out.

What I want to point out is that the processes which are now organized on a big scale in the Philippines originated centuries ago as the result of someone's keen observation and experiment. This particular fish species probably lends itself to the almost domestic treatment it receives. But please note—the original Nauruans, probably trying to imitate what they or their fathers had done elsewhere before, appear to have presented it with difficulties in the nature of the salinity of the water, which are equally well surmounted by the fish. One thing is certain and that is that all the stages are able to find suitable food in plenty. One wonders whether this is not the crux of most, if not all, of the problems which have arisen in fish hatching and fish culture. Another important fact (whether dependent on the one just mentioned or not remains unknown) is the ability of the young fish to thrive in limited confining areas.

I have described this Ibya culture of Nauru because I feel that the *culture* of certain fish as well as of other marine organisms of commercial value may have to play a much more important part in the future than it has in the past. There is no branch of marine biology, however, which is more elusive—it requires patience and will probably need the full resources of the biologist and the chemist. Research of this kind should fully satisfy the pure scientist, whilst appealing equally strongly to the applied scientist. I see no reason why pearl oysters and other molluscs should not be cultivated on the northern coasts of Australia—but we know by now that rule of thumb trials can only result in waste of money—possibly biological research on an attenuated scale is not likely to be a bit better. There is of course another view, that the future will see artificial factory products supplanting the natural, (being more cheaply produced and more easily controlled) and the story of the chemists' aniline dyes destroying the indigo industry will be repeated in the waters as in other fields. But biological science is still too far behind its sisters to say what the future has in store in its bearings on the economic production of commercially valuable living things. I have no doubt that wherever and whenever the call comes for Science to aid in this production, methods will be invented that will overcome the difficulties so far experienced.

The General Study of the Plankton

I have already indicated the importance of plankton studies in fisheries research in referring to the capture and study of fish eggs, and prawn larvae and probably in the future our plankton work at Sydney will be chiefly concerned with a search for the eggs and early stages of fish. Our first investigation, however, has naturally been a more general study of the plankton of the New South Wales coastal waters. This work has been continued over four years, and whilst in comparison with the long continued plankton researches at places in the northern hemisphere the time has been short, yet it is the first continuous investigation in the open sea of this part of the world. From the purely systematic point of view one could go on for many years making collections of plankton with varying gear and possibly getting new species—certainly new records geographically. No doubt, too, there is much physiological research of a purely scientific nature to be conducted on planktonic organisms. What interested us, however, was firstly the question whether there existed in our seas any planktonic rhythm (rhythm in production) comparable to that so much discussed in the northern hemisphere, and secondly what the degree of plankton production was in our waters. The first two years of work sufficed to show us that just as in the northern temperate regions there was a very definite rhythm in productivity with two clearly marked seasons of vigorous reproduction—the early spring and the late summer or autumn—and this was the first demonstration of such a rhythm in the *southern* hemisphere.

Now the explanation of the causes which determine the appearance of the microscopic plants and other organisms in the sea at their appointed times, their development of seasons of reproductive energy, and their disappearance or at least their reduction to smaller numbers, has not by any means been found. I have no doubt further light will be thrown on this fundamental problem of the seasons by researches in different parts of the world at different latitudes and in different environments. There is still dispute, however, as to the comparative annual productivity of the seas in plankton at different latitudes, and since this has a very decided relation to the production of the seas in fish it certainly deserves our consideration.

One of the results of that first great plankton expedition—the Kiel Expedition of the Humboldt Stiftung—was the discovery that the catches were very many times greater in the colder northern seas than in the equatorial Atlantic waters. No doubt this was correlated with the well known northern sea fisheries of Newfoundland, the White Sea, and Iceland, and all seemed to strengthen the belief that for some reason the colder seas were more productive than tropical waters despite the converse on land (assuming that climatic conditions are at their best). A theory was indeed put forward very early by Brandt in explanation. It was based on the assumption that nitrates were the mineral substance in the sea determining its ultimate possibility in plant production, and that these were less concentrated in tropical waters owing to the action of denitrifying bacteria. Possibly there may still be room for some doubt in regard to the differential fertility of tropical seas and temperate seas respectively. There is no question, however, that during the summer months in the Antarctic seas there are enormous developments of planktonic plant-life, and that in temperate waters there are outbursts of great productivity in the springtime.

We have never obtained plankton catches off the New South Wales coast at Sydney as rich as those I used to get in the Irish Sea, and I have no doubt whatever that judged by the actual catches the average number or quantity of organisms in a litre of sea water of the Pacific off Sydney is decidedly less than that to be found in the Irish Sea. This cannot be a simple matter of latitude in its bearing on light or temperature, for there are many seawater lagoons of very great area (Lake Illawarra—80 square miles) along the coast of New South Wales in which the plankton content is high in the summer when the water temperature is as high as that of tropical seas.

It is not by any means easy, however, to determine from the observations that have been made up to date that the *actual production* or fertility of open tropical seas is less than that of open temperate seas. The rate of living is faster in the tropical waters, there is a quicker turnover and rate of reproduction. Even frequent plankton catches do not tell the story so simply as was once thought. It is only during the post-war years, as we have seen, and that notwithstanding the elaborate and costly statistical work, that scientists have realised that the presence of large quantities of big fish in an area does not necessarily mean a big production of fish flesh.

Viewed from a similar angle our quantitative plankton estimations still leave much to the imagination. We have only the most meagre information after years of work expended on far less important issues.

It seems reasonable to assume that *if* the raw materials of plant food were as freely available in the tropical seas as in other waters, the amount of annual production in live organic material would be as great in the one area as in the other—both regions would be equally fertile although a standard net catch or other type of plankton catch in the cold area might reveal more actual organic life than one taken in tropical waters. If, for one cause or another, the raw materials of plant food were richly poured into tropical waters, production there might greatly exceed that in a cold area where such nutriment was sparse. This conception seems more likely to fit the observations which have been made. There are places in tropical waters where rich catches have been made. There are places in temperate seas where the plankton can be poor. And so far as we know, the most fertile places of the world's seas are those where a thorough mixing of the waters is constantly taking place either by reason of inflowing water from the land, or the conjunction of two ocean currents or the upwelling of water along coasts.

Quite recently I have instituted the collection of a series of plankton catches off one of the most isolated tropical oceanic islands in the world—Nauru. Thanks to the keen scientific interest of the present Administrator (Commander Garsia) catches will be attempted every three weeks for a year or more. The first catches which I made myself were moderately rich and diatoms were by no means absent. Yet Nauru is in the supposedly semi-barren tropical Pacific Ocean. Time alone will show whether this richness is due to the influence of the island on the immediately surrounding water. If, however, such is the case, Nauru ought to provide one of the best tropical stations in the world for observing this problem. The island is isolated and only about 3½ miles in diameter so that one should not expect it to exert much if any influence on the island water a few miles away from it. It is a very healthy spot with a big white population and all the amenities of life, and it rises so abruptly from the deep ocean that only two or three hundred feet from the edge of the island's narrow reef flat, the depth is 600 feet or so.

The fact is that the fertility of the sea is greatest along sea coasts and over shallow banks. It is just in such places that we already know of rich fisheries. Whether fisheries can be as rich on shallow banks in the tropics as on similar places in the colder regions seems at present very problematic, in any case practically all the intensive fishing countries which have developed the most modern fish catching machinery are in temperate zones. And I think we may say for certain that in no parts of the ocean have the great whales been found in such numbers as in the Antarctic seas. These whales—blue whales, fin whales and humpbacks—are all plankton feeders. They surely serve as testimonies to the fertility of the southern seas in high latitudes.

All this has a bearing upon research work in our own waters. I should like very much to have plankton catches from colder Tasmanian waters for comparison with those taken by us at Sydney. They would need to be taken with a view to quantitative studies. To my mind, the time has gone by for taking plankton catches merely for the sake of listing new species or cataloguing those present.

Pelagic fish like the herring and the pilchard feed upon planktonic organisms and it has been suggested that possibly the use of plankton capturing apparatus by the skippers of drifters might help in telling them when to shoot their nets. Just as I write this, an article written by the skipper of a steam drifter comes to hand in an English fishing journal. He had been using for three years a 'Plankton Indicator' invented by Professor Hardy of Hull. The idea was that where certain species of the Copepod genus, *Calanus*, were present in large numbers, superior catches might be expected; other plankton organisms were known to be deleterious. During three months of one year the nets were shot 69 times, 40 being in water with little or no *Calanus*, and 29 in water containing 'good' or 'fairly good' *Calanus*. The average catch for the 40 in Calanus-free water was only three crans, whilst the average catch for the other 29 was 9·5 crans, an increase of 216 per cent.

Again on an occasion when the herring fishery in the North Sea made a good start the fish deserted the inshore grounds and were next located about 60 to 70 miles to the north-east, in which position they remained for the rest of the season. A research vessel found that there existed a belt of a minute and apparently deleterious plankton organism—*Phaeocystis*—extending one hundred miles east and west. There seemed little doubt that this was an obstruction to the herring.

Lastly there is another very important aspect of plankton work and that is the search to determine whether and how it may be responsible for the great fluctuations in the successful reproduction of our food fishes. There is evidence that in the 'bad years' (i.e. the years which are later on badly represented in the catches) there has been no lack of fertilized eggs produced. The 'poor vintage' may, therefore, be due to these eggs meeting unhealthy physical and chemical conditions in the sea, or maybe the newly hatched young find only a poor development of plankton of the right kind when this is so very essential as food material.

CONCLUSION

I trust my remarks tonight have been sufficient to show that a branch of zoology which may definitely be called Fisheries Science is gradually developing. The progress has been slow. For many years the proper relation of its subdivisions was not realized and certainly those engaged had little notion of the underlying complexities. Many investigators were too well satisfied with their intriguing little problems in marine biology to consider whether their application to fishery problems was obvious enough to balance the expenditure of time and money upon them. And so far as England was concerned, and possibly this is equally true of the

United States, any brilliant investigators in marine zoology probably looked ahead for positions which were not to be found under fishery committees—their association with fishery problems was thus temporary and continuity of research was lacking. This criticism, however, does not apply so much to the Germans and Scandinavians. Times have changed now and the work of the immediate future should be particularly interesting.

Not so very many years ago the opinion was frequently expressed that the yield of the sea was infinite. Did not the females of certain fish species produce 7,000,000 eggs in one spawning season! A simple view, for it is clearly as necessary for such a species to produce its 7,000,000 eggs if the stock is to remain *constant* as it is for the whale to produce its single young each year or the shark its twenty or thirty.

The highly efficient engines of modern fisheries have induced other ideas and from all over the world come stories of fish depletion. I have indicated some in the above account. Let me conclude by referring to another from a country near to us—New Zealand.

Mr. A. E. Hefford, the Chief Inspector of New Zealand Fisheries, in his Report of 1929, was particularly to the point when he said that the

'all important consideration for fishery Administration and for the fishing industry is as to how far the reduction of a stock of fish can proceed before the condition which can be termed positive depletion, has been reached . . .

'And especially we must recognise that there is no reason to think that New Zealand Fisheries may be developed to the same degree as those of Europe or North America. *There is no indication of anything approaching the same extent of fishery resources as those of the Northern Hemisphere. There is all the more reason, therefore, for studying what assets we have, with a view to their most economical exploitation*'. (Italics mine).

This is an interesting expression in view of the prevalent opinion in Australia as to the richness of New Zealand waters.

The fundamental problem facing the science of Sea Fisheries is everywhere the same—the valuation of the fishery stocks and the determination of what is going on when man adds his attack to the fluctuations of nature.

I am not going to suggest for a moment that Australia should institute anything on the extensive lines followed by the United States of America, Japan or England. Far from it. I am not at all convinced yet of the supposed enormous richness of our fishery resources. Why should I be in view of the lack of what I call real knowledge. I regard as pure blague the statement that Australia has the greatest fishing coast in the world. Time enough to make comparisons when we know more about it.

It is essential, however, that we should do something, and in a manner that will ensure that what is necessary is done in the most economical way. This implies that it must be efficiently carried out and by people thoroughly qualified to do the work. There is only one body in Australia that is in a position to regard the scientific work in the proper perspective and that is the Commonwealth Council for Scientific and Industrial Research. In their hands I can leave it.

Although it is not altogether to be placed under the head of scientific research, I am quite of the opinion that under the conditions peculiar to Australia, the Government might well undertake to help in the discovery of new fishing grounds and the investigation of the best fishing gear for use on them. The seas are open to all and the industry should benefit many beyond those directly engaged in fishing.

At the present time most of our trawlers are unable to explore beyond the 100-fathom line, although some of the most useful fishing in the world is now carried out at twice that depth. There are now French trawlers with refrigeration plant and storage for 700 to 800 tons of frozen fish, retorts for cooking lobsters, plant for the reduction of fish into oil and scrap, and storage tanks for 26,000 gallons of oil. Trawlers of this kind will travel across the Atlantic to their fishing grounds and remain away for weeks at a time.

The vast field of the pelagic fishes so intensely valuable to other countries has been left altogether unexplored commercially around Australia. The pilchard was worth 3,587,464 dollars to California in 1929, the value of the herring alone landed in Great Britain in one year may be over £5,000,000. How can these pelagic fish be caught best in our waters? Will the drift net, the purse seine, the lampara or other devices prevail? The problem entails a big experiment—it is not exactly one for a private company or individual since the results are for the many. There will be no exclusive licenses.

The Commonwealth Government has now agreed to make these explorations for pelagic fish and in making that decision I think it has done well. Let us not make the mistake of missing. the opportunity for conducting statistical and other pure fishery research when these experimental explorations are made. It is cheaper to investigate resources in advance rather than after depletion has taken place.

One of the greatest dangers that Science faces today is that of being expected to produce some great discovery to order, which will bring considerable wealth for an extremely low expenditure. It has been well said that the average individual's interest in science is the hope of getting something for nothing. I regret to say that some of the most sanguine promises have been made to the fishing industry.

I see no reason why scientists should promise the fishing industry easy money. Their work is rather to be regarded as essential to the people for the proper conservation and the utilisation of nature's products. To the fishery industry it might be regarded at least as an insurance although it might turn out a most profitable investment.

I have no doubt that explorations at sea and tests of new fishing gear will show up new grounds and may improve the catching power of the appliances used. This, however, is relatively simple work, involving fishing technique rather than the finer studies of science.

But all this work without the institution of better methods of transportation and marketing would result in worsening the present economic conditions in the industry instead of bettering them. I do not think I can agree with the view that the lack of scientific research up to date has been responsible for the slow development of the Australian fishing industry. There are many other causes. The so-called fresh fish as received by the Australian housewife is, in most localities, a burlesque of the real thing.

The help of the scientist in the development of up-to-date and really modern canning industries, refrigeration methods, the utilization of waste products, the preservation of fishing nets, the propagation of shell-fish, the toxicity of paints and poisons to marine growths, and in the solution of a large number of other problems, is of course, obvious to most.

The use of plankton studies, the study of life histories, of fish eggs, the study of the prevailing hydrographic conditions in the sea and the expenditure of money on the statistical analyses of our fish stocks, are not so obvious. Such researches might result in new culture methods, they might help to discover the secret of the curious fluctuations in the riches of the sea and to make forecasts of the fisheries possible. They will certainly help to an understanding of the conditions upon which fishery legislation must be based, for to have Fishery Acts and Regulations without knowledge cannot be sufficiently condemned.

Unfortunately, so long as neither fishermen nor those who govern us are ever told or instructed as to the reasons why much of the scientific work is conducted, it will never be found possible to enlist the help and sympathy which are so essential to success.

There have been, during the past few years, many cries in the newspapers for Government help in connexion with fisheries. Perhaps if those making most noise had been really altruistically concerned about the general advance of the fishing industry of Australia, something more might have been achieved than the state reached at present.

Unfortunately most of the reproaches have come from interested company promoters whose one idea of Government help was the obtaining of money grants in order to float new concerns, the future of which might be left to unhappy shareholders. This would be a disastrous waste of money and quite against all the advice of the numerous witnesses and experts who attended the meetings of the Commonwealth Fisheries Conference during the years 1927-9.

The only reason the promoters of the projects referred to above have applied to the Governments is because they have met with little response from the investing public. The investing public have probably refrained because they realized that the projects were based on incomplete data.

There are plenty of bonafide fishermen all round the Australian coast and no doubt many business men of standing who would enter into or extend the fishing trade if *shown* that *constant supplies* of fish were available in the sea and markets were forthcoming for their products. To explore every possible line of enquiry might well be regarded as the duty of a Government; to hand over money to any 'Tom, Dick and Harry' is something which John Citizen would be the first to criticize.

Some years ago a British official from India visited Japan in order to study its fishery methods. In his report he noted that much of the Japanese success was due to the 'Co-operation of Government and people: The Government statesmanlike, resolute in progress on lines systematically thought out and determined, imbued with the scientific spirit, liberal in the necessary expenditure; the people responsible, enterprising, alert to utilise opportunity and to follow example'.

I should like to stress that attitude and to remind you, in conclusion, that it is from a flourishing fishing industry that the great maritime nations have recruited some of the best and most desirable men for the merchant service and the navy.

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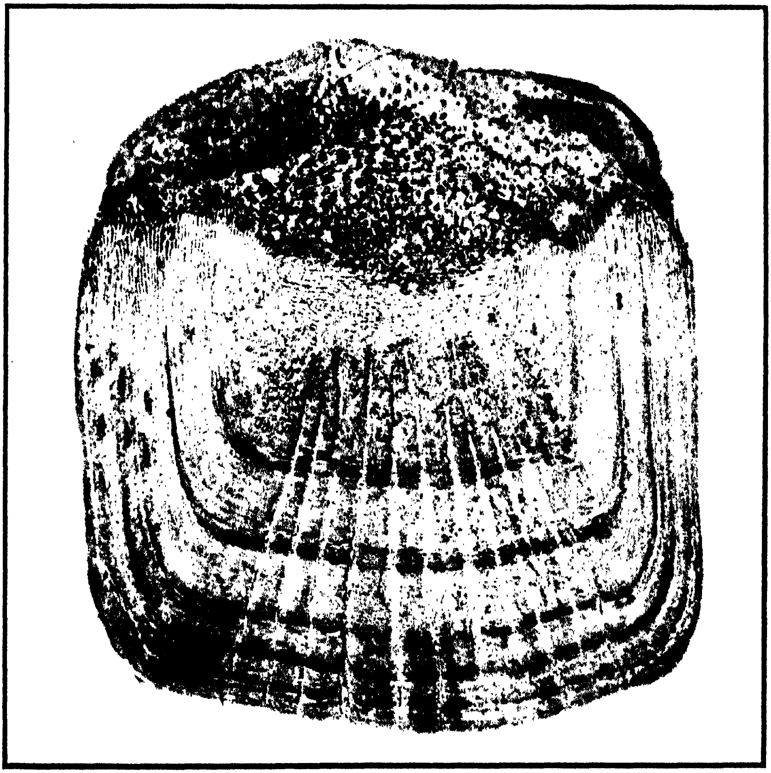
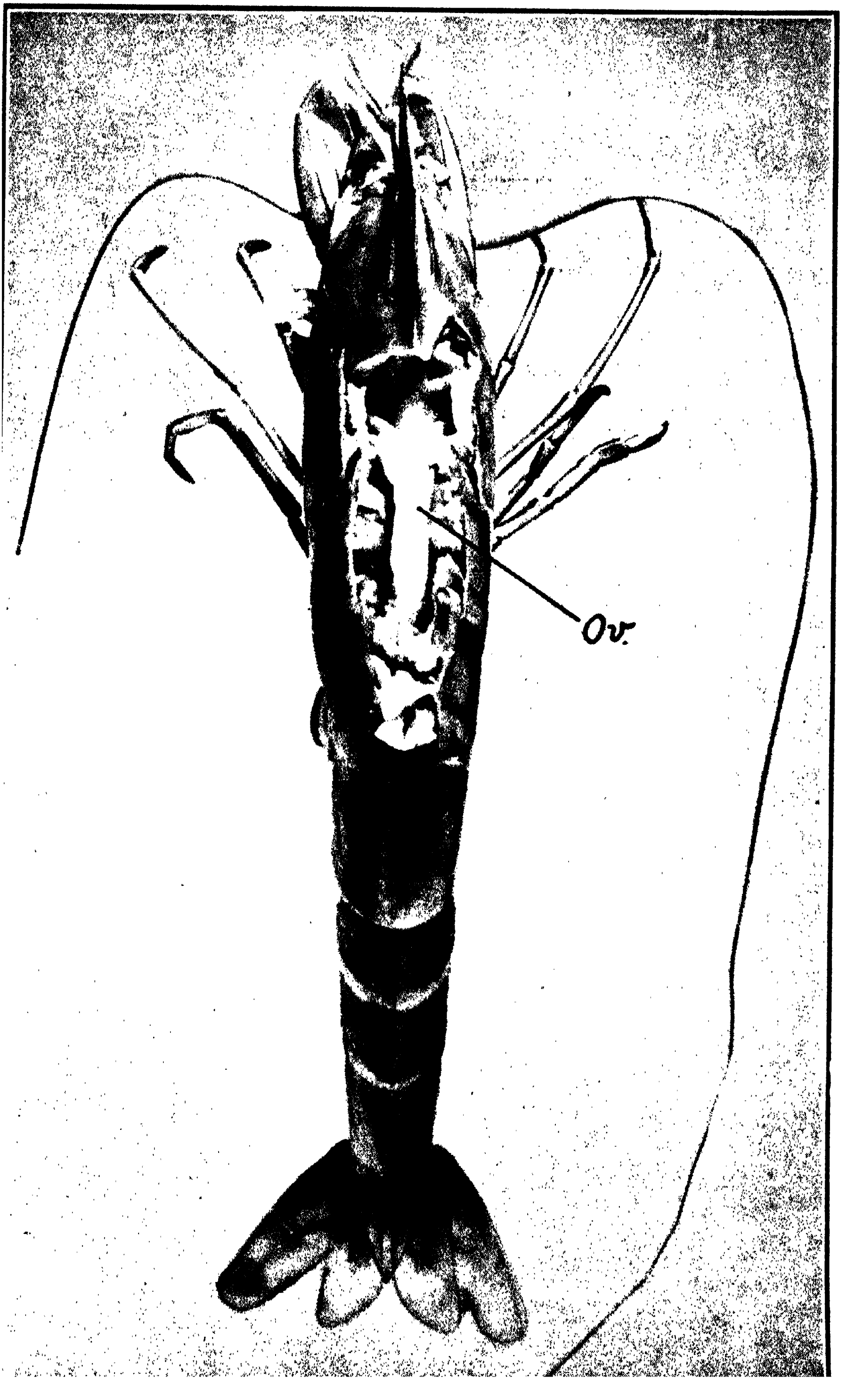
EXPLANATION OF PLATES

Plate I.—Scale of Tasmanian Trumpeter (low magnification).

Plate II.—King Prawn *(Peneus plebejus)*, female, almost mature, showing ovaries (ov.).



Scale of Tasmanian Trumpeter. (Low magnification).


Ov.

On a New Genus of Fishes of the Family Galaxiidae

By

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ONE PLATE AND TWO TEXT FIGURES

(Read 16th July, 1934)

Family GALAXIIDAE.

Paragalaxias, gen. nov.

Diagnosis.—Differs from *Galaxias* and *Neochanna* in having the teeth in the jaws biserial: also differs from the members of both genera, except *Galaxias dissimilis* Regan (see *Remarks*), in having the dorsal fin inserted well forward, at about level of ventrals. Vertebrae fewer than in other members of the family. Ventrals six-rayed. Size apparently small.

Orthotype.—*Paragalaxias shannonensis*, sp. nov.

Habitat.—Tasmania. Fluviatile.

Paragalaxias shannonensis, sp. nov.

(Plate III)

General form moderately stout, subcylindrical anteriorly, somewhat compressed posteriorly. Head moderately depressed; snout obtuse; interorbital region gently convex. Size small. Jaws equal anteriorly [lower sometimes projecting very slightly]. Maxillary extending almost [usually quite] to vertical from anterior margin of eye. Branchiostegals [8–9]. Gill rakers on lower part of anterior arch [12–13]. Vertebrae [22 + 22 = 44 + urostyle].

Dimensions. Total length 40·7 mm. [25·5 mm.–39·2 mm.]; length to base of middle caudal rays 33·8 mm. [21·3 mm.–32·8 mm.].

Proportions. Depth of body 7·6 [6·3–7·9] in total length, or 6·3 [5·4–6·6] in length to base of middle caudal rays. Head 4·4 [4·2–4·7] in total length, or 3·7 [3·6–3·9] in length to base of middle caudal

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[1] *Conventions.*—Definitive numerical characters are in general those of the holotype: items in square brackets relate throughout to paratypes. Dimensions and proportions have been determined with an a_2 (35 mm.) Zeiss objective, and Leitz No. 0 ocular with ocular micrometer. *Total length* means length from tip of snout to end of caudal rays. *Emargination-index*: this term, proposed in the belief that it will be found generally useful, is defined thus:—the difference in backward horizontal extension of the median and lateral caudal rays, measured from the base of the former, and expressed as a decimal of the latter; the fin being in the normal expanded condition.

rays. Snout 3·8 [3·7–4·1] in head; eye 4·2 [3·7–4·6] in same, or 1·1 [1·0–1·2] in snout, or 1·1 [1·0–1·3] in interorbital width.

Teeth. Biserial in both jaws: arranged in each premaxilla (Text fig. 1A) and each ramus of the mandible (Text fig. 1C) in an outer series of about 20, subequal, subconical, bluntly pointed, somewhat recurved, averaging one to one and a half times as long as their interspaces; and in an inner series of about 14, directed inwards and slightly upwards, larger, more compressed, more sharply pointed than those of the outer series, their interspaces about equal to, or less than, their length. On each entopterygoid (Text fig. 1B) a single series of about 8, fairly comparable with those of the inner series in the jaws, their interspaces, which progressively increase backwards, averaging rather more than their length. On the tongue (Text fig. 1D) two lateral series, each of 6–8, diverging posteriorly, the anterior pair, which are almost or quite contiguous basally, usually the largest, three to four times as large as those of the outer series in the jaws, bluntly pointed, much recurved.

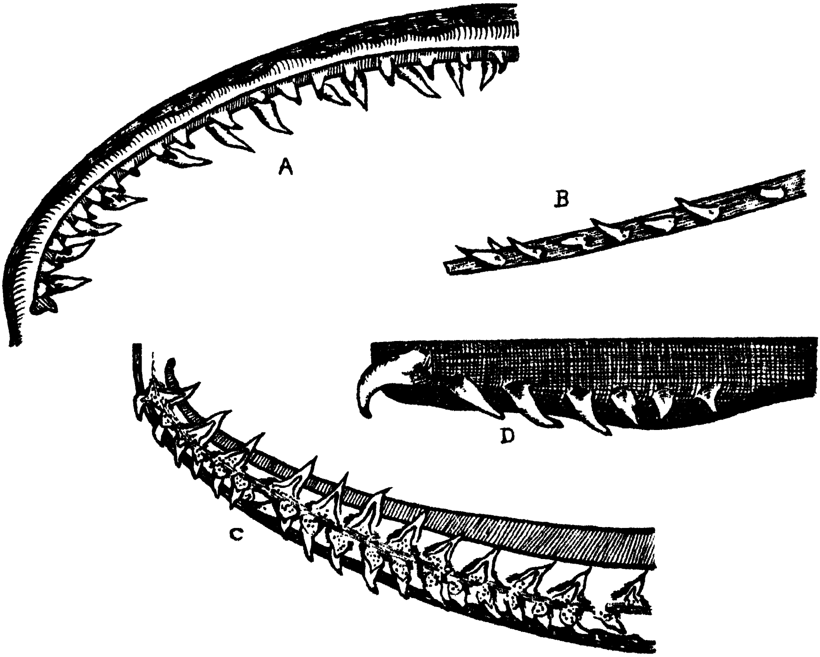

Fig. 1.—*Paragalaxias shannonensis*, sp. nov. Teeth enlarged.
A.—premaxillary. B.—entopterygoid. C.—mandibular. D.—lingual.

Nostrils and Mucus-pits (Text fig. 2). Nostrils large, the anterior nearer to tip of snout than to orbit, the posterior about twice as far from anterior as from orbit. Mucus-pits most evident on dorsal surface of head, where there are six, relatively very large.

Dorsal fin. Large; fourteen [fourteen–fifteen] rays, thus, II + 11 + I [II–III + 11 + I]: in several of the smaller paratypes all rays remain unbranched, their stems quite uncleft, and the pencillate extremities that characterise all rays and ray-branches scarcely, or not, distinguishable into two tufts. Originates virtually above base of ventral, being behind level of latter by 1·4% [0·9%–1·4%] of total length without caudal: distance from its origin to base of caudal 2·7 [2·5–2·7] in total length, or 2·2 [2·2–2·3] in length without caudal. Its largest, 5th [5th or 4th], ray with its membrane 1·8 [1·6–2·1] in the head; its base 1·4 [1·1–1·5] in the same, or 1·3 [1·0–1·5] in its distance from caudal. Laid back, reaches level of base [base-middle] of last anal ray laid back, its total horizontal extension being between one-third and one-fourth total length without caudal.

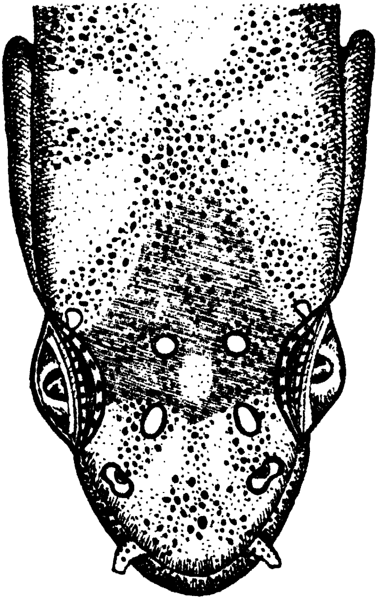

Fig. 2.—*Paragalaxias shannonensis*, sp. nov. Dorsal aspect of head, showing anterior and posterior nostril, and mucus-pits; enlarged.

Anal fin. Moderate; nine rays, thus, II + 6 + I [II + 6 + I]: in several of the smaller paratypes all rays remain unbranched, as in dorsal. Originates below 12th [11th–12th] dorsal ray. Its longest, 4th [4th or 5th], ray with its membrane 2·1 [2·0–2·4] in the head; its base 2·7 [2·3–2·7] in the same, or 1·8 [1·5–1·8] in its distance from caudal. Laid back, virtually reaches caudal ridge [usually fails to do so by ½–⅔ length of its last ray].

Pectoral fins. Large, distinctly pedunculated; 12 [11–13]; extending 0·8 [0·7–0·9] of the distance from their origin to origin of ventrals.

Ventrals. Six-rayed, thus, I + 4 + I [I + 4 + I]; originating very slightly in advance of dorsal, at a point about equidistant from anterior margin of eye and base of caudal; extending 0·8 [0·7–0·9] of the distance from their origin to origin of anal.

Caudal fin. $13 + \frac{c.\ \mathrm{IX}}{c.\ \mathrm{XI}} \left[12\text{–}13 + \frac{c.\ \mathrm{VIII\text{–}XI}}{c.\ \mathrm{VIII\text{–}XI}} \right]$; its length 5·9 [6·1–6·4] in total length; emargination-index 2·4 [2·3].

Caudal peduncle. 2·3 [2·1–2·4] times as long as deep; its length 0·6 [0·5–0·6] in postorbital portion of head.

Life-Colours. General colour translucent greenish, blotched or barred with greenish brown. The pattern varies considerably, but characteristically, as in the holotype, consists of 10–12 large blotches tending to form subvertical bars, from once to twice as wide as their interspaces, in linear series along the side, and of similar blotches, sometimes forming well-marked saddles, on the back. No special scapular bar. Under surface paler than sides and back, minutely punctuated with darker behind vent, and usually also, though more lightly, in a narrow cross-zone near level of base of pectorals. Head in general concolorous with body; a dark blotch near occiput; no dark streak beneath eye. Iris golden, heavily spotted, especially superiorly, with blackish; pupil blackish. Operculum with briliant metallic green-gold blotch. Fins pale, immaculate (macroscopically), often with distinct greenish tinge basally. Through the transparent body-wall the enteric canal shows metallic greenish gold, and the vertebral column is seen to arch slightly over the silver air-bladder, which is embraced by about 10 pairs of ribs, while the dorsal aorta and its backward extension as the caudal artery are traceable as a dark blue, almost black, line.

Under a lens the body exhibits numerous black chromatophores, subcircular or stellate, the latter type much resembling those of *Galaxias attenuatus*, and chiefly constituting the body-bars; there are also scattered small subcircular orange spots. In all fins rays are white, with, occasionally, some orange spots near the base, these being few except on the caudal, where they extend thickly over the proximal two-thirds, or more, of the ray; rays with a row of black chromatophores along either border. Membrane in all fins mainly white, sometimes somewhat greenish basally, with scattered orange and black spots, much more abundant and conspicuous on caudal than on any other fin.

Material Examined. Described from the holotype (figured), seven paratypes, and paratypic microscopical preparations (from which teeth are figured). Holotype (Regd. No. HT939a), a paratype (Regd.

No. PT939b), and slides of paratypic material (Regd. Nos. PT. sl. 939c-n) in the collection of the Queen Victoria Museum, Launceston, Tasmania. Paratypes will be offered to the British Museum (Natural History), London; Australian Institute of Anatomy, Canberra; Australian Museum, Sydney; National Museum, Melbourne; Tasmanian Museum, Hobart; and Museum of the Biology Department, University of Tasmania, Hobart.

Locality. Shannon River, Tasmania. Three specimens collected on 3rd December, 1933, remainder (about a score) between 29th March and 2nd April, 1934: all from two small beds of water-weed (*Potamogeton* sp.), one situated about two or three yards, the other about forty yards, below the road-bridge over the Shannon between the Great Lake hydro-electric dam at Miena and the Shannon Lagoon. Secured with a hand-net (a method by which, in my experience, members of the genus *Galaxias* are very rarely obtained), along with half a dozen two-four inch specimens of *Salmo irideus* Gibbons.

As pointed out by Tillyard (1933), this stretch of fast-running water, about half a mile in length, has a well-marked ecological character. It is famous among anglers for its phenomenal rises of the so-called Shannon Moth, a handsome undescribed snowflake-caddis of the genus *Smicridea*, on which the introduced Salmonidae feed voraciously.

Remarks. The presence of ventral fins and of teeth on the entopterygoid, and in addition the general appearance and habits indicate a closer affinity with *Galaxias* than with *Neochanna*.

Except for *Galaxias dissimilis* Regan (1906), believed to be from New South Wales, and *G. cleaveri* Scott (1934), from Tasmania, each of which rests on a single specimen, the present is the only known Australian member of the family with six-rayed ventrals.

The anomalous *G. dissimilis*, for the reception of which the traditional concept of *Galaxias* as a genus with the dorsal in a markedly posterior position had to be modified, has long been a puzzle. McCulloch (1921, p. 28) went so far as to suggest that 'The unique holotype of this species is perhaps merely an abnormal specimen'; while Whitley (1933) in making available the first figure (Pl. XII, Fig. 2), a sketch by Regan, remarked (p. 61) that it 'may not be congeneric with' a species of *Galaxias* (*G. o'connori*) just discussed. The present form may perhaps shed light on this long-standing problem, as a comparison of its characters, apart from the dentition, with those of *G. dissimilis*, as described and figured, suggest the two are probably congeneric.

Should a re-examination of the dentition of *Galaxias dissimilis* show that this species should enter the present genus, it would be distinguishable from *P. shannonensis* by, among others, the following characters:—snout in *dissimilis* 'much longer than eye,' in *shannonensis* subequal to eye; maxillary extending in *dissimilis* to below anterior ¼ of eye, in *shannonensis* not so far as, or just to, level of anterior margin of eye; one to two more dorsal rays in *shannonensis* than in *dissimilis*; caudal *peduncle* in *dissimilis* $1\frac{2}{3}$ as long as deep, in *shannonensis* more than twice (average, 2·2 times) as long as deep.

The collection of the greater part of the material here dealt with has been made possible by the granting by the University of Tasmania of a research scholarship for an investigation of the Tasmanian Galaxiidae: grateful acknowledgment is made of this assistance, also of permission to submit the present paper, as a separate section of the report, to this Society. To Mr. V. V. Hickman, B.Sc., B.A., Ralston Lecturer in Biology, in whose Department the administration of the grant lay, thanks are tendered for much kind encouragement and assistance.

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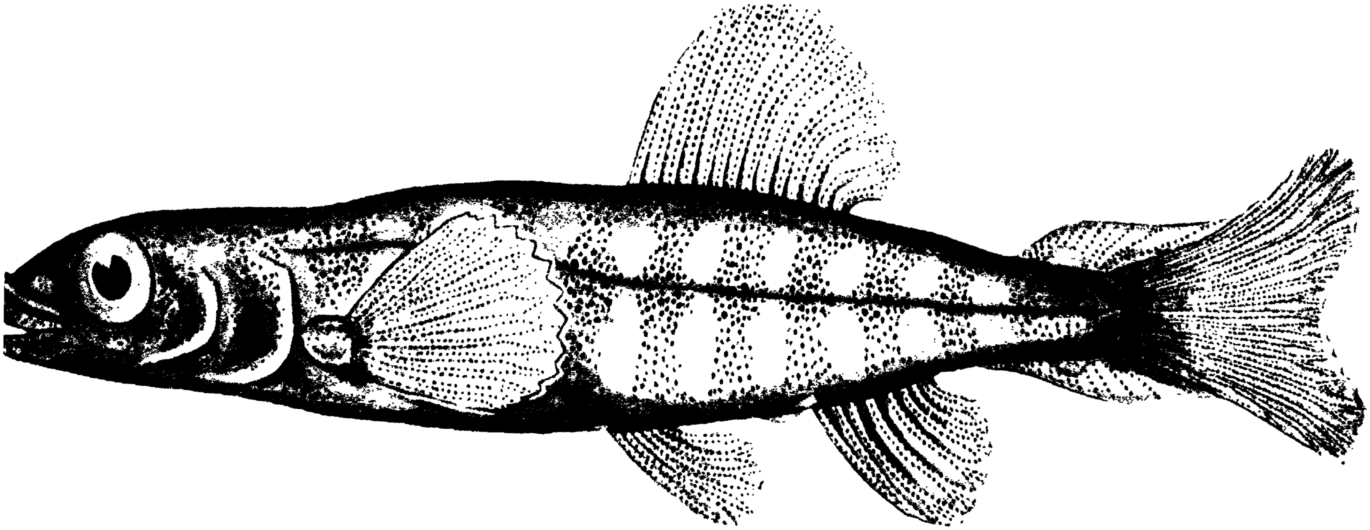
EXPLANATION OF PLATE

Plate III.—*Paragalaxias shannonensis*, sp. nov. Holotype. Locality, Shannon River, Tasmania. Total length 40·7 mm.



Paragalaxias shannonensis, sp. nov. (E.O.G.S. 2/1)

Notes on the Gobies Recorded from Tasmania, With Description of a New Genus

By

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ONE PLATE AND TWO TEXT FIGURES

(Read 26th September, 1934)

Four species of Gobiidae have at various times been accredited to Tasmania. It cannot be said, however, that our knowledge of the members of the family occurring in our waters at present rests on a very satisfactory footing. In the present paper, the more precise scope and conclusions of which are summarized in the concluding paragraph, some notes on the recorded forms are given, and a new genus is described.

Registration numbers are those of the Queen Victoria Museum, Launceston.

Family GOBIIDAE

Genus **Nesogobius** Whitley, 1929

Nesogobius hinsbyi (McCulloch and Ogilby)

Gobius pictus Castelnau, *Proc. Zool. Soc. Vict.* I. 1872. p. 124: preoccupied by *G. pictus*, Malm. 1865. *Id.* Macleay, *Proc. Linn. Soc. N.S.W.* V. 1881. p. 599.
Gobius hinsybi Johnston. *Pap. Proc. Roy. Soc. Tas.* 1902 (1903). Abstract. p. 10 : *nomen nudum*. *Id. Waite, Rec. S. Aust. Mus.* II. 1. 1921. p. 146. fig. 229. *Id.* Lord, *Pap. Proc. Roy. Soc. Tas.* 1922 (1923). p. 70. *Id.* Lord and Scott, *Synop. Vert. Anim. Tas.* 1924. pp. 73 and 82.
(Gobius) hinsbyi McCulloch and Ogilby, *Rec. Aust. Mus.* XII. 10. 1919. p. 215. pl. XXXIII. fig. 1: *ex* Johnston MS.
Nesogobius hinsbyi Whitey, *Pap. Proc. Roy. Soc. Tas.* 1928 (1929). p. 62. *Id.* McCulloch, *Aust. Mus. Mem.* V. III. 1929. p. 369.

Locality. McCulloch and Ogilby's Tasmanian specimens came from Wedge Bay, Tasman's Peninsula. I find the species is abundant in pools between tide-marks at Burnie, and West Ulverstone, N.W. Coast.

Life-Colours. The following notes on the colours during life were made from a specimen, 54 mm. in total length, obtained by the writer at Burnie, on 7th August, 1934 (Reg. No. 942a).

General colour above sandy, made up of greyish white dotted and reticulated with golden-brown. Six narrow bars of olivaceous brown on back, the first, which is interrupted mesially, just behind level of preopercular margin, second at level of opercular margin, third near middle of first dorsal, fourth near middle of second dorsal, fifth behind level of second dorsal, reached by that fin laid back, sixth just in advance of origin of caudal ridge: except the first and second, these bands extend down to about midlateral line, uninterruptedly in last two, interrupted by a forward displacement of the lateral element in others. Sides concolorous with back down to midlateral line, where they pass, rather sharply, into white, which continues over the whole ventral surface: along line of demarcation a greyish band, formed by blackish punctulations, which is best-marked and widest below spinous dorsal. Seven moderate sized, dark brown, almost black blotches along midlateral line, extending half into upper sandy, and half into lower white region; the first elongated vertically; first three covered by adpressed pectoral; last, at base of caudal, Y-shaped with the azygous limb directed forward. From midlateral line to ventral profile run about a dozen very narrow subvertical pale golden brown bars, somewhat irregularly spaced, and scarcely extending behind level of termination of soft dorsal.

Head in general concolorous with body. Behind eyes a dark indeterminate transverse bar, subcontinuous with a sharply defined, almost black bar on operculum, immediately behind, and following outline of, posterior margin of preoperculum; a blackish streak from eye towards angle of mouth; a short black subvertical streak below, but not reaching to, anterior portion of eye. Iris in general greyish brown, freckled with darker brown; pupil narrowly ringed with shining golden orange.

Dorsals with colourless membranes, bearing punctulations that give rise to pale brownish regions forming three or four arcs, the narrower interspaces whitish; these markings rather more conspicuous on first dorsal. Posterior margin of first dorsal with a conspicuous broad white marginal band. Pectorals and anal almost colourless, lightly barred with fawn. Ventrals colourless distally, thickly spotted with opaque pearly white proximally: the general appearance of the fins is beautifully white, tinged in parts with fawn, and exceedingly delicate and feathery.

Variation. As pointed out by McCulloch and Ogilby (1919, p. 216), there is considerable variation in colour-marking. A series of nine specimens (Reg. Nos. 942 a-i) yields the following notes. Narrow transverse bars present only in largest specimen; five specimens with white spot on occiput; three with white spot on superior border of pectoral base; three with white markings on cheek and operculum; seven with white mid-dorsal spot near origin of first dorsal, and a less conspicuous one near origin of second dorsal; opercular stripe scarcely developed in smaller individuals; dorsal cross-bars very variable in width and intensity; five to seven dark blotches along midlateral line, rather variable in extent and intensity, usually squarish, except the one at caudal base, which is either Y-shaped, or else composed of an anterior blotch and an adjacent or confluent vertically elongated stripe, often the darkest element of the whole series; occasionally small spots, perhaps representing incipient vertical bars, between, and slightly below, the main lateral blotches.

The principal proportions of these nine specimens—the largest, 54 mm. in total length, from Burnie, the remainder, 26·2 mm.–46 mm. in total length, from West Ulverstone and near Goat Island—are noted below for comparison with those of the 86 mm. specimen from Wedge Bay, described by Ogilby and McCulloch. Depth before ventrals 4·6–5·8 in length to hypural joint; head 3·1–3·7 in same. Eye 3·4–4·1 in head, and 0·8–1·3 in snout, which is 2·9–4·1 in head. Depth of caudal peduncle 3·5–4·3 in head. Breadth before pectorals 0·96–1·12 in depth there.

None of my specimens has more than seven spines in first dorsal, but, it is of special interest to note, two have six only. D. VII, 9 in six specimens; VII, 10 in one; and VI, 9 in two. A. I, 8 in eight specimens; I, 9 in one. P. 18-20. V. I, 5. C. 13 + $\frac{c.\ 4 - 10.}{c.\ 4 - 11.}$

Habits. This attractive species is tolerably common in pools between tide-marks at Ulverstone and Burnie, and I have observed what is apparently the same form in great numbers along a shallow sandy bank of the River Leven, about a mile inland. It is very swift moving, and when disturbed darts away with celerity, either to the shelter of a rock, or, remaining in the open, coming to a halt after a yard or two, and resting on the sand, into which it often buries itself to the depth of the midlateral line, the white lower half of the body thus becoming entirely hidden, while the exposed half, with its delicate mottlings of grey and golden brown, harmonizes admirably with the surrounding sand. When at rest, or when disturbed while in a vessel, it not unfrequently completely lowers the dorsals, so that they become scarcely discernible. Though decidedly shy, it is at times captured with little difficulty by sliding a flat stone beneath the sand on which it is resting, and flicking it bodily into a waiting net. It appears to show a marked preference for pools whose bottoms are wholly or partly sandy, and I have found it in general useless to seek it in those of a purely rocky character.

Remarks. The following additions may be made to the excellent description by Ogilby and McCulloch. B. 6. Gill-rakers on lower limb of anterior arch about 6, mamilliform. The double series of mucigerous papillae running towards the angle of the mouth is subcontinuous with a double series on the inner mandibular margin. On the caudal there occurs a series of pore-disks: this regularly comprises a mesial row, present on either surface of the membrane, running from near caudal base to, or almost to, posterior margin of the fin, and commonly includes also one or two shorter, less regularly constituted lateral rows, of which the lower is the more constantly present.

Synonymy. McCulloch and Ogilby with little hesitation relegate to this species *Gobius pictus* Castelnau (not of Malm). As Castelnau's species, from St. Kilda, Melbourne, has not hitherto otherwise been recognized, the suggested synonymy is probably correct. At the same time, however, since Whitley (1929, p. 62) has assessed the presence of more than six dorsal spines—a feature on which McCulloch and Ogilby laid considerable emphasis in advocating this identification—as a character of generic value, it is worth recalling, as a memorandum for future investigation, that Castelnau's description includes some points—*e.g.*, lower jaw projecting, second dorsal spine lower than the others—not readily compatible with the present species.

Genus **Arenigobius** Whitley, 1930

Arenigobius tamarensis (Johnston)

(Plate IV, fig. 1)

Gobius tamarensis Johnston. *Pap. Proc. Roy. Soc. Tas.* 1882 (1883). p. 120. *Id.* Macleay, *Proc. Linn. Soc. N.S.W.* IX. 1. 1884. p. 32. *Id.* Johnston, *Pap. Proc. Roy. Soc. Tas.* 1890 (1891). p. 33. *Id.* Lord, *Pap. Proc. Roy. Soc. Tas.* 1922 (1923). p. 70. *Id.* Lord and Scott, *Synop. Vert. Anim. Tas.* 1924. pp. 13 and 81. *Id.* Whitley, *Pap. Proc. Roy. Soc. Tas.* 1928 (1929). p. 61. *Id.* McCulloch, *Aust. Mus. Mem.* V. III. 1929. p. 370.
(Gobius) tamarensis McCulloch and Ogilby, *Rec. Aust. Mus.* XII. 10. 1919. p. 229.
Gobius lateralis ? Lord and Scott, *Synop. Vert. Anim. Tas.* 1924. p. 81.
Gobius tasmanicus Whitley, *Pap. Roy. Soc. Tas.* 1928 (1929). p. 62; *ex* Johnston MS.

Historical Note. Johnston's original description of his *Gobius tamarensis* is a brief one, occupying some twenty lines in his catalogue. So far as I am aware, the species has not been recognized since Johnston's time; and accordingly a redescription and figure are here offered. A discussion of the synonymy outlined above is conveniently postponed till the species has been described, and hence appears under a separate heading below.

Description. B. 5. D. VI, 9. A, I, 8. P. 18-20. V. I, 5. C. 13 + $\frac{c.\ 2-5}{c.\ 2-5}$. Scales between axilla and hypural joint, 32–33, and between anterior dorsal and anal rays 11–12. Gill-rakers on lower limb of anterior arch about 7, stout, elongated, cylindroconical.

Greatest depth 6·4–7·3 in total length; depth at level of pectoral base 1·1 in breadth there, and 5·6–6·4 in length to hypural joint. Head 3·4–3·7 in length to hypural. Eye 1·2–1·3 in snout, which is 3·8–4·0 in head. Interorbital width 2·4–2·8 in eye. Depth of caudal peduncle 2·0–2·8 in its own length, and 2·7–3·4 in head.

Head entirely naked; moderately depressed, its depth 1·1–1·4 in its greatest breadth, and 1·0–1·3 in breadth at level of hinder orbital margin. Cheek and opercles with rows of mucigerous pores, arranged as shown (Plate IV, fig. 1). Open pores present in rows along nuchal grooves; several scattered rostral pores, and an interorbital one. Snout convex, obtusely conical. Anterior nostril in a short tube, about thrice as far from eye as from margin of preorbital; posterior nostril in a scarcely developed tube, about midway between anterior nostril and orbit. Eyes moderate, cutting the dorsal profile. Interorbital space slightly concave. Mouth oblique; jaws subequal anteriorly, or lower distinctly projecting; maxilla extending to below middle, or, exceptionally, posterior third, of eye. No barbels or cirri. Anterior premaxillary teeth in four rows; the outer three rows villiform, but exhibiting some gradation in size, on the whole 3rd > 2nd > 1st row; inner row large, acute, tending to increase in size backwards: behind the middle of the jaw, reduced to two or three rows, those of the outer row, or rows, larger than they are anteriorly, and two or three teeth of the inner row, just behind the middle of the jaw, caniniform, inwardly curved. Palate toothless. Mandibular teeth in about five rows anteriorly, decreasing, by loss or confusion among the middle rows, to three or four posteriorly; outer row cardiform, increasing somewhat in size posteriorly; next three rows villiform, more closely spaced than first row; inner row large, acute, inwardly curved, increasing in size backwardly to about the middle of the series, where there are two or three markedly caniniform. Tongue broad; its posterior half adnate to floor of mouth; its free anterior margin shallowly, somewhat broadly notched. Gill-openings chiefly lateral, a little wider than the isthmus, the breadth of the latter more than length of snout. Exposed edge of shoulder-girdle smooth.

Body fairly robust, subcylindrical anteriorly, compressed posteriorly. Covered with ctenoid scales; angular and rather large posteriorly, where they extend for one or two rows, especially laterally, on to the caudal base, more rounded and smaller anteriorly, where they cease, on the dorsal surface, at about the level of the hinder edge of the pectoral base mesially, and a little in advance of the posterior opercular border laterally, and, on the lower surface, at about the level of the origin of the ventrals; pectoral base naked. Genital papilla moderate.

First dorsal beginning above the anterior fourth of middle pectoral rays; the length to its origin 2·8–2·9 in length to hypural; its base 2·2–2·5 in its distance from tip of snout, and subequal to postorbital portion of head; first spine about one and one-half times as long as last, and about one and one-third in longest (5th), which latter is rather more than half head; laid back, reaches to, or nearly to, origin of second dorsal. Interdorsal 3·0–4·0 in base of first dorsal, and less than eye. Second dorsal beginning behind level of vent; the length to its origin 1·8–1·9 in length to hypural; its base 2·6–2·8 in its distance from tip of snout, and subequal to combined length of base of first dorsal and interdorsal; its longest (3rd) ray but little longer than succeeding rays, and subequal in large specimens to base of the fin; laid back, fails to reach level of base of middle caudal rays by less than length of its own last ray, which is relatively longer in larger specimens. Anal beginning about below, or a shade behind, second ray of soft dorsal, and ending just behind soft dorsal; the length to its origin 1·7–1·8 in length to hypural; its base 2·9–3·6 in its distance from the snout, and about two-thirds length of head; similar in general form to, but lower than, soft dorsal; laid back, fails to reach level of base of middle caudal rays by a distance varying from rather more than length of its own last ray, in smaller specimens, to less than two-thirds of same, in larger specimens. Pectoral inserted just anterior to ventral; somewhat narowly rounded; without free silk-like rays; its longest (about 10th) ray rather more than one and one-half times postorbital portion of head, and reaching, when adpressed, about to level of middle of interdorsal. Ventrals united; with a well-developed anterior interspinous membrane; their longest (5th) ray subequal to base of anal, and reaching, when adpressed, nearly, or quite, to vent. Caudal pointed, the median rays, which are somewhat produced, 1·0–1·3 in head.

General colour of body (in formalin) varying above from pale greenish grey to dull greenish brown, below from white to pale, faintly greenish grey. Scales of the back and sides narrowly margined posteriorly with blackish, being minutely and abundantly punctulate with sepia, the punctulations extending over the whole scale in darker specimens, but being confined to the posterior half or two-thirds in lighter examples; scales of ventral surface immaculate. In some specimens there are four rather indefinite dark bands across the back, not, or scarcely, discernible in others, which extend about to the midlateral line, the first at level of first dorsal, second rather behind middle of second dorsal, third just behind that fin, fourth near middle of caudal peduncle. A row of small to moderate dark spots along midlateral line, about nine between axilla and caudal base, the last the most conspicuous of the series. Upper surface and sides of head in some specimens very pale greenish, almost white, minutely punctulated with darker greenish, in others brownish, similarly punctulated, but also coarsely blotched and vermiculated with dark brown; a dark streak from eye towards angle of mouth; lower surface pale greenish grey. Dorsals and anal grossly hyaline, membrane and rays, particularly the latter, punctulated with brown, showing a tendency in darker individuals towards the formation, especially in the dorsals, of rows of spots and bars; extremities of the rays usually blackish. Caudal with about six rows of dark spots, chiefly developed radially. Pectoral faintly dusky greenish, more or less heavily punctulated with brownish. Ventrals pale yellow, occasionally dusky, especially distally, on account of the presence of dark punctulations.

Material examined. Described from five specimens in the collection of the Queen Victoria Museum, Launceston (Reg. Nos. 940 a-e), two lighter individuals, 75 and 67·5 mm. in total length, the smaller of which is figured, obtained 12th March, 1934, three darker individuals, 84·5, 77, and 72·5 mm. in total length, part of a series of ten, obtained 18th April, 1934.

Locality. River Tamar, Tasmania; first series from Launceston wharf, second series from upper reaches of river near Tamar Island.

Synonymy and Taxonymy. Two main questions arise in regard to the synonymy, first, that of the identity of the species with *Favonigobius lateralis* (Macleay), secondly that of its identity with *Gobius tasmanicus* Whitley.

Johnston himself (1883, p. 120) noted regarding his *G. tamarensis*, 'This species approaches very close to *Gobius lateralis* (Macleay).' Succeeding writers without access to specimens—*e.g.*, Macleay (1884, p. 32), McCulloch and Ogilby (1919, p. 229)—have in general been content merely to quote this observation; but Lord and Scott (1924, p. 81), while according *G. tamarensis* a separate heading, express the opinion it is 'probably identical with' Macleay's species. While presenting considerable general resemblance to *Favonigobius lateralis*, as described and figured by McCulloch and Waite (1918, p. 48; Pl. II, fig. 3), the present species may readily be distinguished from that form by, among other characters, its larger number of scales between pectoral base and hypural, and between anterior dorsal and anal rays, the naked pectoral base, the presence of an extra ray in the dorsal, the notched tongue, and nature of the dentition. The degree to which the laid-back soft dorsal and anal extend towards the caudal base appears to vary in both species with the size of the individual, and to be without diagnostic value.

Gobius tasmanicus Whitley is founded upon a short description, with some general measurements of a specimen 69 mm. long, given, under that name, in Johnston's MS., dealt with by Whitley (1929, p. 62). A comparison of the description of *G. tamarensis* and *G. tasmanicus* shows agreement in the following points:—dorsal and anal radial formulae; height one-seventh of total length; head naked, depressed, one-fourth of total length; snout obtuse, convex; eyes approximated; size 2-3 inches: while both are common in the River Tamar. The positive differences noted include:—branchiostegals 4 in *G. tamarensis*, 5 in *G. tasmanicus*; a small difference in the size of the eye; and a rather marked difference in colouration. The difference in the count of the branchiostegals I cannot bring myself to regard as being of great significance; the variation in the size of the eye is more than covered by the range exhibited by the specimens described above; and while a general comparison of a particularly light coloured, little marked specimen with a particularly dark coloured, much marked specimen might well suggest a specific difference, I find a complete gradation between the two extremes in colour exhibited by individuals between which a detailed examination fails to reveal any other differences. With the doubtful exceptions of 'pectoral reaching to vertical from third ray of second dorsal' in *G. tamarensis*, the pectoral not extending beyond the origin of that fin in any of my specimens, and 'all the teeth small' in the same species, the characters of *G. tamarensis* and *G. tasmanicus* recorded in the description of one only of the two species, and therefore not directly comparable, are compatible with those of the specimens here described. On the whole, in the light of the information now available, I feel little hesitation in regarding *G. tasmanicus* as a synonym of *G. tamarensis.*

After long deliberation, I place this form in *Arenigobius* Whitley. I do so, however, rather as an indication of its general affinities than with any fixed feeling that, when the last word has been said on the Australian genera, it will necessarily remain there. Though the first step towards the solution of the problem of the relationships of the many Australian species originally described under the general name of *Gobius* was taken when McCulloch and Ogilby (1919) first gave adequate descriptions of, and a key to, some of these, and further important advances were made when Whitley (1928, p. 224) instituted *Berowra,* with *(Gobius) lidwelli* McCulloch as orthotype, and (1929, p. 62) *Nesogobius*, with *(Gobius) hinsbyi* McCulloch and Ogilby as orthotype, and later (1930) proposed seven generic names for other species of *(Gobius)* included in McCulloch and Ogilby's key, it is evident there is still a long way to go before the whole matter reaches finality. The present species exhibits close affinities with the species of *Arenigobius* in the important items of the shape of the tongue, and the character of the dentition, but differs from them in the somewhat produced lower jaw, and the smaller number of dorsal and anal rays: it approaches nearer to *A. semifrenatus* than to the genotype, *A. bifrenatus.* It may be observed that McCulloch and Ogilby (1919, p. 204) place these species in their key, to which Whitley (1930, p. 122) in instituting *Arenigobius* refers, in the division 'breast and pectoral base scaly,' but in describing *A. bifrenatus* state (p. 243) that the scales 'extend forward to above the operculum, leaving the nape and the pectoral base naked.' From *Berowra lidwelli,* which, under 'breast and pectoral base naked,' stands immediately adjacent in the key, the present form is readily separable. It finds its nearest ally among extralimital genera with Australian representatives in *Glossogobius* Gill, from which it seems to differ mainly in the degree of notching of the tongue and in the enlargement of some only of the outer teeth. A review of the information at present at my command leaves me with a suspicion that it may at some time be necessary to establish an Australian genus, intermediate in some respects between *Glossogobius* and *Arenigobius*, in which the present species, possibly accompanied by others, may rest.

Genus **Favonigobius** Whitley, 1930

Favonigobius lateralis (Macleay)

Gobius lateralis Macleay, *Proc. Linn. Soc. N.S.W.* V. 4. 1881. p. 602. *Id.* Waite, *Rec. S. Aust. Mus.* II. 1. 1921. p. 146. fig. 230. *Id.* Lord, *Pap. Proc. Roy. Soc. Tas.* 1922 (1923). p. 70. *Id.* Lord and Scott, *Synop. Vert. Anim. Tas.* 1924. pp. 13 and 81. *Id.* McCulloch, *Aust. Mus. Mem.* V. III. 1929. p. 371.

Rhinogobius lateralis McCulloch and Waite, *Rec. S. Aust. Mus.* I. 1. 1928. p. 48. pl. II. fig. 3.

Favonigobius lateralis Whitley, *Aust. Zool.* VI. 2. 1930. p. 122.

Remarks. This species is not included in either of Johnston's Tasmanian lists, nor is it accredited to Tasmania by McCulloch (1929, p. 371). It first appears, so far as I can ascertain, in the list of Lord (1923, p. 70), which is a simple enumeration of species only; and it is also included by Lord and Scott (1924, pp. 13 and 81), with a reference to Macleay's description, but without records of specimens, or comments. I can find no further mention of it in connexion with Tasmania.

The presence of this species on our local lists appears to be an error. It is, I am inclined to think, traceable to a simple misunderstanding, for which I venture to suggest the following possible explanation. Johnston (1891, p. 33) lists under the heading family Gobiidae two species, namely, *Gobius tamarensis* Johnston and *Callionymus lateralis* Macleay, the Callionymidae being, of course, in Johnston's time included in the Gobiidae—Günther (1861, p. 138), whom Johnston largely followed, placing *Callionymus* and allied genera in his 'fourth group' (virtually subfamily) Callionymina, and Macleay himself (1881, p. 628) not separating in any way his *C. lateralis* from any of the other genera of the Gobiidae as then understood. It seems, in these circumstances, at least possible that—aided perhaps by an unconscious association of ideas centring round the word *lateralis*, an association that might well have been reinforced by Johnston's own direct comparison of *G. tamarensis* with *G. lateralis*—Johnston's record of *Callionymus lateralis* Macleay was inadvertently picked up as *Gobius lateralis* Macleay.

That Johnston's own record really referred to *Callionymus lateralis*, and not to *Favonigobius lateralis*, is placed beyond doubt by the radial formulae accompanying it. Moreover, *Callionymus papilio* Günther, of which *C. lateralis* Macleay is a synonym, is a species well established on our faunal list, and is duly accredited to Tasmania by McCulloch (1929, p. 338).

C. papilio now enters the recently constituted genus *Foetorepus* Whitley (1931, p. 323).

Tasmanogobius, gen. nov.

Diagnosis. Without developed, superficial scales, but with pectinate groups of spines, that probably relate to rudimentary, embedded, non-imbricating scales; transparent. Body elongated, subcylindrical. Pores surrounded by disks, simulating photophores, present in complex system on head, in metameric series on body, and on caudal fin. Head not compressed. Snout blunt. Mouth oblique; jaws subequal. No barbels or cirri. Teeth in several rows anteriorly, those of the outer series much enlarged. Palate toothless. Tongue free anteriorly, produced mesially. Gill-openings extending well forward below; gill-membranes united across a moderate isthmus. Exposed edge of shoulder girdle smooth. Gill-rakers short, stout, about 8 on lower limb of anterior arch. First dorsal with 7 (rarely 6) spines; originating near middle of pectoral; not united with soft dorsal. Soft dorsal and anal similar, the latter slightly the shorter; with about 14-16 rays; ending far in advance of caudal. Pectoral rounded, without specialized rays. Ventrals I, 5, conjoined; with anterior interspinous membrane. Caudal subtruncate; with many procurrent rays. Size apparently small. Myomeres 8 + 18.

Orthotype.—*Tasmanogobius lordi*, sp. nov.

Habitat.—Tasmania.

Tasmanogobius lordi, sp. nov.

(Plate IV, fig. 2; and Text figs. 1 and 2)

B. 6. D. VII [in one paratype VI], 15 [15–16]. A. I, 13 [I, 13–15]. P. 18 [19]. C. $15 + \frac{8}{8}$ [$15 + \frac{8}{8} - 17 + \frac{10}{10}$]. Gill-rakers short, stout, mamilliform, 8 on lower limb of anterior arch.

Depth 7·3 [7·1–8·0] in total length, and 6·2 [6·0–6·7] in length to base of middle caudal rays. Head 5·1 [4·6–4·9] in total length, and 4·3 [4·0–4·1] in length to base of caudal. Snout 1·0 [0·96–1·1] in eye, and 3·9 [3·9–4·4] in head. Interorbital width 3·8 [3·1–4·4] in eye. Caudal peduncle 5·7 [6·2–7·1] in length to base of caudal, and greater than base of first dorsal; its depth 2·2 [1·8–2·2] in its length, and about three times head.

Head naked, transparent. Its posterior width, and width at level of hinder orbital margin subequal to corresponding depths. Snout broadly rounded from above, obtusely conical in profile. Anterior nostril large, in a short, rather wide tube, placed about midway between orbit and upper lip, and subcontinuous with the short, scarcely developed tube of the posterior nostril, which opens immediately in advance of orbit. Eyes moderate, usually cutting the dorsal profile, the transparent covering that is continuous with the skin of the head always doing so. Interorbital space slightly convex. Mouth decidedly oblique; jaws subequal anteriorly, the lower sometimes slightly projecting; maxillary extending to, or slightly beyond, level of anterior orbital margin. No barbels or cirri. Premaxillary teeth in a single cardiform row in the hinder third of the jaw; anterior to which they are chiefly in two rows, with indications of an intercalated third row near the middle of the series; those of the outer row all large, recurved, rather blunt near the symphysis, increasing in size and acuteness backwards to just beyond middle of jaw; remainder fairly acute, somewhat recurved, subequal, about half as large as the largest of the outer row. Palate toothless. Mandibular teeth in about three rows anteriorly, decreasing to a single row just before they cease behind; those of the outer row greatly enlarged, elongate, rather blunt, markedly recurved, subhorizontal anteriorly, becoming smaller, relatively stouter, more nearly vertical as they continue backwards; those of the middle row moderate throughout, subequal posteriorly to those of the outer row, moderately acute, recurved; those of the inner row smallest, most acute, least recurved. Tongue free in its anterior half; its broad anterior margin produced mesially. Gill-openings continued forward below about to level of posterior preopercular margin; gill-membranes united across a moderate isthmus, subequal to snout. Exposed edge of shoulder girdle smooth.

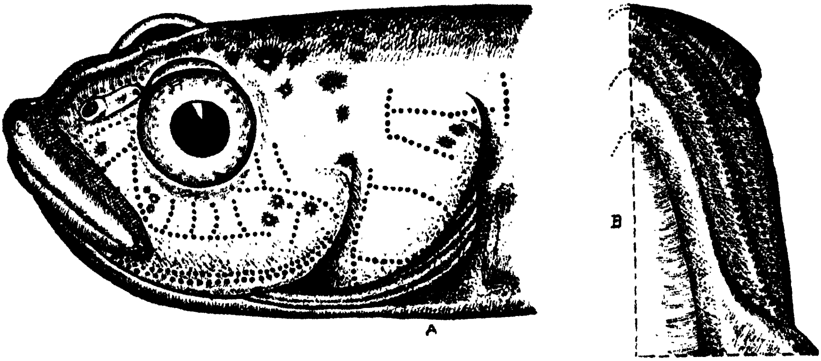

Fig. 1.—*Tasmanogobius lordi*, sp. nov.
A.—Head, lateral aspect, slightly tilted. × 10. B.—Lower jaw, ventral aspect of left half. × 10.

Head with a complex system of pores (Text fig. 1, A, B): the double series running forward towards the lower lip (Text fig. 1, A) continuous or subcontinuous with the double series on the chin (Text fig. 1, B). Each pore surrounded by a sharply defined, more or less opaque disk, 80–100 μ in diameter, and set ⅓–⅔ of its diameter from its neighbour, the whole structure somewhat simulating a photophore.

Body transparent, elongated, subcylindrical; breadth at origin of soft dorsal 1·3 [1·1–1·5] in depth there, and breadth at termination of soft dorsal 1·1 [1·1–1·4] in depth there. Pore-disks, the detailed structure of which, as seen in a slide of the skin, examined with a Natchet No. 7 objective and a Leitz No. 0 ocular, is shown in Text fig. 2 B, are present in subvertical or forwardly convex rows

(Text fig. 2 A) along the side, one to each myomere, the posterior series extending for about five-sixths of the depth of the body, and comprising about a dozen disks, the anterior series usually shorter, with fewer disks. Genital papilla small to moderate.

Without developed, superficial scales; but with non-imbricating pectinate groups of spines, which probably relate to rudimentary scales, arranged in one or three rows posteriorly, as indicated diagrammatically in Text fig. 2 A, and in five or seven similarly staggered rows anteriorly. Usually the spines are wholly embedded, and in preserved specimens invisible without dissection: in several individuals, however, they pierce the integument in the region covered by the adpressed pectoral, presenting a curious superficial resemblance to the spine-groups of some species of Cyclopteridae, *e.g.*, *Lethrotremus vinolentus* Jordan and Starks. Spines 3–12 in a series, the larger groups restricted to the anterior portion of the body; with broad, non-contiguous bases; each series associated with, but apparently not in contact with, an amphioxid spicule-like basal plate (Text fig. 2 C), in advance of which are at times to be found indications of ordinary scale structure.

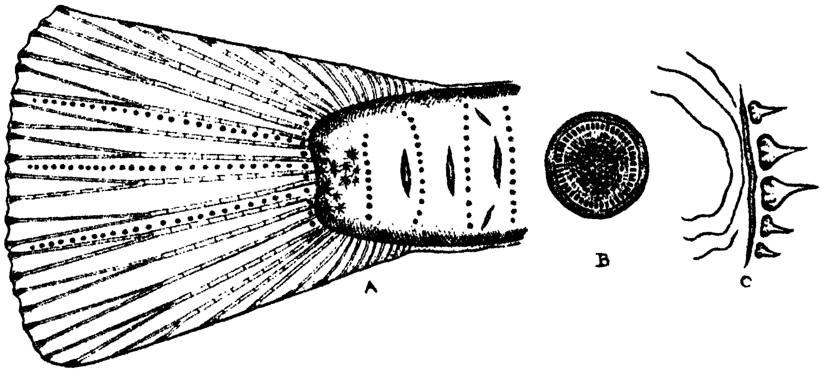

Fig. 2.—*Tasmanogobius lordi*, sp. nov.

A.—Caudal peduncle (with position of basal plates of spine-groups indicated diagrammatically) and caudal fin. × 10. B.—Pore disk. × 150. C.—Spine group and associated scale structure. × 100.

First dorsal beginning at, or behind, middle of pectoral; the length to its origin 3·0 [2·9–3·0] in length to base of middle caudal rays; its base 2·7 [2·5–3·3] in its distance from tip of snout, and subequal to postorbital portion of head; first spine two to three times as long as last, and about one and one-third in longest (3rd), which latter is about one-third length of head. Interdorsal 1·5 [1·1–1·9] in base of first dorsal, and about one and one-half times eye. Second dorsal beginning shortly behind vertical from vent; its height about two-thirds that of the body beneath it; the length to its origin 1·9 [1·8] in length to base of middle caudal rays; its base 1·9 [1·8–2·0] in its distance from tip of snout, and about two and one-half times base of first dorsal; first ray about one and one-quarter times last, and about twice in longest (3rd), which latter is subequal to interdorsal. Anal beginning below interval between 1st and 2nd rays of soft dorsal, and ending about below the penultimate ray of that fin; the length to its origin 2·1 [2·0–2·1] in length to base of middle caudal rays; its base 2·1 [2·0–2·1] in its distance from tip of snout, and about one and one-tenth length of head; similar in form and subequal in height to soft dorsal. Pectoral inserted in advance of ventrals; rounded, obscurely pointed; the majority of the rays branched; upper rays not free from membrane; longest (about 11th) ray rather longer than portorbital portion of head, and reaching, when adpressed, to below 4th [3rd–5th] dorsal spine. Ventrals united, somewhat cup-shaped, not adnate to belly; rays deeply divided, doubly forked from, and usually including, the second onwards; 5th ray longer than 4th, but not greatly so, and subequal to interval between anterior margin of eye and posterior margin of operculum; reaching, when adpressed to, or, a little beyond, midway between its origin and origin of anal. Caudal rounded truncate, the middle of the fin extending horizontally backward beyond the postero-lateral angles by about one-fifth of the length of the median rays, which latter are 1·3 [1·4–1·5] in head; a well-developed series of 8 or 10 procurrent rays above and below. Low ridges connect the caudal with the soft dorsal and the anal fins. Pore-disks on caudal in a vertical basal row, from which run back a midlateral row, and, on either side of it, separated by two, sometimes three, rays, a lateral row: this pattern, which is indicated on one side only of the membrane in Fig. 1 C, occurs on both surfaces of the membrane.

Total length 34·4 mm. [31·7 mm.–34·3 mm.]; length to base of middle caudal rays 29·2 mm. [28·6 mm.–29·3 mm.].

In life transparent; scarcely discernible in the water except for the conspicuous dark eyes. A row of about nine small fawn markings along the midlateral line, the first, below the anterior third of the spinous dorsal, usually the darkest, and regularly forming a narrow subvertical bar, ½–⅔ as high as the body; the third, fifth, and seventh, below the origin, middle, and termination of the soft dorsal respectively, and the ninth, at the end of the caudal peduncle, showing some tendency towards vertical elongation, and commonly larger than the alternating ones, which are subcircular; in one paratype only the posterior three markings are present, the last of these alone being conspicuous. Fawn markings, variable in character, occur on the back. When best developed, as in the holotype, they take the form of seven double bars, made up of subcontinuous longitudinally elongated blotches, and extending slightly on to the sides; the first series in advance of, second below, spinous dorsal, third on interdorsal, fourth-sixth below soft dorsal, seventh near base of procurrent caudal rays. In paratypes they tend to be broken up into spots, each double series, except the first, which in several cases shows a quincunical arrangement, coming more or less definitely to consist of four dots disposed roughly as at the angles of a square. A row of from eight to twelve small spots along either side of base of anal, as often as not continued back to the anterior procurrent caudal ray. A conspicuous Y-shaped series of dark dots on the ventral surface, the unpaired limb extending mesially from about level of preopercular margin to base of ventrals, where it forks to give rise to two shorter limbs covered, but not hidden, by the conjoined fins. Head variably spotted and punctulated; but regularly with well-marked streak from below eye to angle of mouth, and behind eyes two small blotches, which may be subcontinuous anteriorly, or posteriorly, or both; usually also with more or less definite spots on cheek, behind middle of eye, near posterior preopercular margin, and on operculum; in some specimens two short rows of spots run forward from eye along dorsal surface of snout; lips with faint irregular blotches and some minute punctulations; ventral surface of head immaculate. Pectoral base, which is well developed, lightly punctulated., Dorsals and anal colourless to the naked eye, but all with microscopic punctulations, most numerous basally and posteriorly in the first dorsal, and externally in the other fins. Caudal with dusky marking at base, in sequence with lateral body-series; in some individuals with groups of brownish punctulations forming two or three more or less evident transverse arcs. Pectoral colourless, with a few scattered microscopic dots, particularly basally. Ventrals with numerous punctulations, usually rendering them dusky, particularly distally.

Material examined. Described from the holotype (Plate IV, fig. 2), five paratypes, and mounted paratypic material. Holotype, a paratype, and slides in the collection of the Queen Victoria Museum, Launceston (Reg. Nos. HT.941a, PT.941b, and PT.sl. 941c-g respectively). Paratypes will be offered to the British Museum (Natural History), London; Australian Institute of Anatomy, Canberra; Australian Museum, Sydney; and National Museum, Melbourne.

Locality. Mouth of the River Leven, Tasmania. Not uncommon, in association with *Nesogobius hinsbyi*, in sandy pools formed by the retreating tide behind the retaining wall near the breakwater, West Ulverstone. Several days' collecting in the neighbourhood, while rewarded with other specimens of *Nesogobius hinsbyi*—and, among non-gobioid material, *Atherina tamarensis*, and the usual *Pictiblennius tasmanianus*, *Cristiceps australis*, *Clinus perspicillatus*, *Alabes* spp., and *Parvicrepis cardinalis*—failed to yield further examples.

Named in honour of the late Clive Errol Lord, Director of the Tasmanian Museum, and for fifteen years Secretary of this Society, the most notable local worker in systematic ichthyology since R. M. Johnston's time.

Remarks.—I am unable to suggest the affinities of this form, and have been constrained to establish a new genus for its reception. In addition to the fact that it shares with the otherwise dissimilar

Nesogobius hinsbyi the distinction of being the only known Australian goby with seven dorsal spines, it appears to be readily distinguishable upon other grounds from the described Australian genera; nor are its characters compatible with those of any of the extralimital genera to descriptions of which I have access. My grateful thanks are tendered to Mr. Gilbert P. Whitley, Ichthyologist, the Australian Museum, Sydney, who, in response to inquiries, very kindly referred for me to some extralimital literature on the family—in particular Jordan and Seale's review of the gobies of Oceania—not available in Tasmania.

SUMMARY

1. Four species of Gobiidae have been accredited to Tasmania. Notes on these are given, as indicated seriatim below, and a new genus is described.

2. *Nesogobius hinsbyi* (McCulloch and Ogilby). Life-colours, habits, variation, and new localities recorded; general observations and remarks.

3. *Arenigobius tamarensis* (Johnston). Redescribed and figured; its affinities with *Favongobius lateralis* (Macleay), and its generic status discussed.

4. *Gobius tasmanicus* Whitley. Shown to be probably a synonym of *Arenigobius tamarensis* (Johnston).

5. *Favongobius lateralis* (Macleay). Considered to be accredited to Tasmania in error; an explanation of its presence on some local lists suggested.

6. *Tasmanogobius*, gen. nov., described; orthotype, *Tasmanogobius lordi*, sp. nov., described and figured.

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Explanation of Plate

Plate IV—

Fig. 1.—*Arenigobius tamarensis* (Johnston). Topotypical specimen. Total length 67·5 mm.

Fig. 2.—*Tasmanogobius lordi*, sp. nov. Holotype. Locality, mouth of River Leven, Tasmania. Total length 34·4 mm.

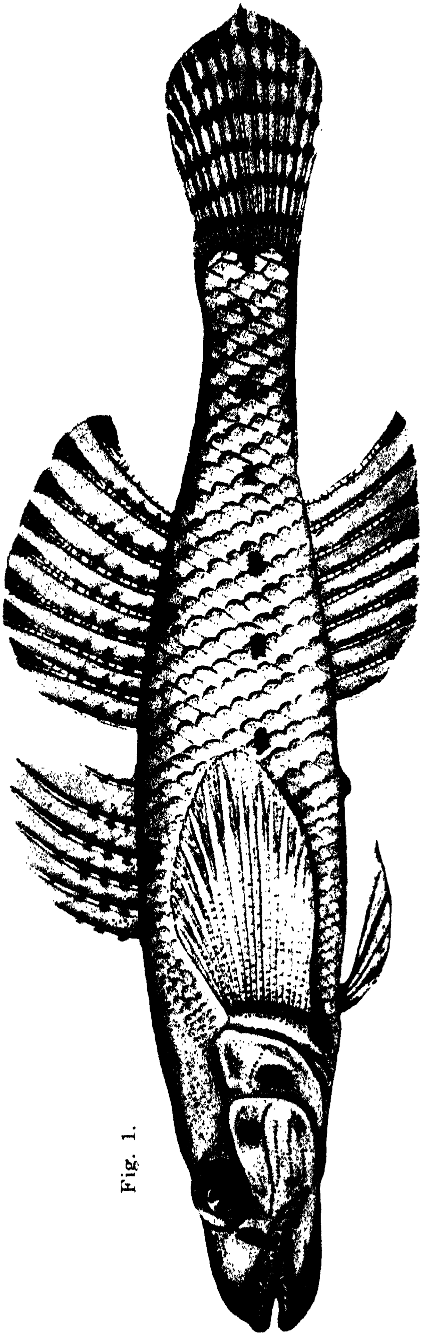

Fig. 1.

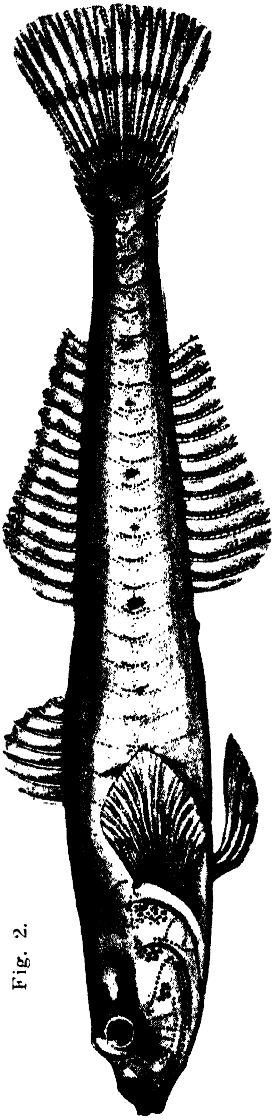

Fig. 2.

Fig. 1.—*Arenigobius tamarensis* (Johnston). [E.O.G.S. del.] Fig. 2. - *Tasmanogobius lordi*, sp. nov.

Observations on Some Tasmanian Fishes
Part II

BY

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WITH ONE PLATE

(Read 3rd December, 1934)

The present paper has the same general aims as, and may be regarded as being a continuation of, a previous contribution by the writer (1934): its precise scope is summarized in the concluding paragraph.

Registration numbers are those of the Queen Victoria Museum, Launceston.

Family HEMISCYLLIIDAE

Genus **Parascyllium** sp. nov.

Parascyllium multimaculatum, sp. nov.

(Plate V, fig. 1)

Description. Head to last gill-slit (111·5 mm.) 2·1 times its width at level of eyes (52), and 6·4 in total length (710). Depth of body, between pectoral and anal, where it is greatest, (65) 1·7, at origin of second dorsal (26) 4·3, in head. Eye (13) 9·0 in head, 2·6 in snout (34), which is 3·3 in head. Preoral portion of head (9) 3·8 in width of mouth (34).

Body elongate, somewhat depressed anteriorly, subcylindrical posteriorly; its width at origin of first dorsal (35) rather more than its height there (32). Head large, greatly depressed; snout rather large, broadly rounded from above, depressed and obtuse in profile. Spiracle minute (less than 1 mm. in diameter), behind and below posterior angle of eye, its distance from which (10) is 1·3 in diameter of eye (13), and 3·0 in interorbital width (30). A longitudinal fold beneath eye. Gill-slits.—1 < 2 < 3 : 4 < 5; first (6) 2·3 in last (26), which latter is 1·3 in snout; first nearer to spiracle than to origin of pectoral; fourth and fifth close together, over base of pectoral. Internarial distance (18) 2·7 in interspiracular distance (48). Nasal cirrus short, fairly thick, reaching to lip; exterior nasal fold with a short, blunt lobe at its postero-external angle. Lower labial fold extending about halfway to middle of jaw; continued well round angle of mouth.

Teeth in upper jaw in about seven closely set rows mesially; small, elongated, bulbous just above the base, the distal half flattened and acute; in lower jaw similar in number and form, but with the basal bulb sometimes forming a pair of incipient lateral cusps.

First dorsal originating further from tip of snout (360) than from tip of caudal (350); its base (40) 1·2 in its height (48), and 2·5 in interdorsal space (101), which latter is equal to length to origin of pectoral. Base of second dorsal equal to that of first dorsal, and subequal to its own height (42). Dorsals subequal in form, apex rounded, posterior margin slightly concave mesially, and forming rather more than a right angle with lower margin. Anal low, ending at level of origin of second dorsal; length to its origin (453) 1·3 in length to origin of superior lobe of caudal (582); its base (46) 2·1 times its height (21). Pectorals broadly rounded; base (33) 1·8 in length (61), which latter is 3·2 in total spread of these fins (194). Ventrals longer than broad, their length along inner border (67) 1·2 times length of main cartilage of clasper (58); outer margin broadly rounded; posterior angle pointed; length to their origin (264) 2·2 in length to origin of inferior lobe of caudal (571). Greatest depth of caudal (32), occurring at first fourth of portion in advance of notch, 4·3 in its total length; depth at notch (18) 1·7 in length of portion behind notch.

General colour pale grey, tinged with brown, becoming almost white below, particularly in advance of ventrals. With about ten rather indeterminate bars of rusty brown on the sides, disposed as shown, in general subtriangular, the apices not, but exceptionally almost, attaining the ventral profile, the broad bases virtually confluent on the back; one of these bars, a shade darker than the rest, forms an ill-defined nuchal collar, tapering on the sides, and ceasing at the horizontal level of the anterior insertion of the pectoral, just below the gill-slits, the posterior three of which it embraces. Sides and back of body ornamented with very numerous scattered small dark brown spots, often somewhat darker on the body-bars; about 50 of these spots on either side between the verticals from the origins of the dorsals. Dorsal and lateral surfaces of head in advance of spiracles uniform dark brown; its whole ventral surface whitish, except preoral region, which is light slate grey.

Dorsals mainly concolorous with body-bars, a shade lighter along the posterior border; each with ten or twelve dark spots. Pectoral and ventral concolorous above with the dorsals, beneath with the lower preoral region of head; on both surfaces somewhat paler towards the posterior and inner borders; each pectoral with above half a dozen, each ventral with about a dozen, dark spots. Anal concolorous with ventral surface of body; with one large elongated, and three or four small, rounded dark spots. Upper half of caudal concolorous with body-bars, bearing dark markings that are elongated to form several small longitudinal stripes along the superior border; lower half lighter, with a number of subcircular dark spots.

Material examined. Described and figured (Plate V, fig. 1) from the unique holotype male in the collection of the Queen Victoria Museum (Reg. No. HT983). The specimen, which was secured by Mr. C. Andrews, was mounted and presented by Mr. G. R. F. Green: I had, however, previously examined it, and all dimensions recorded above are those of the fresh fish.

Locality. Tamar Heads, Northern Tasmania.

Affinities. *Parascyllium multimaculatum* is readily distinguished from the other members of the genus by the insertion of the first dorsal behind the middle of the total length—a character which, while it would certainly provide a convenient subgeneric criterion, is, I think, best regarded, at any rate for the present, as being of specific value only—and by the colour-markings.

From *P. variolatum* Duméril and *P. ferrugineum* McCulloch it is further chiefly distinguished by having the anal inserted wholly in advance of the second dorsal; also from the first species in possessing a supplementary lobe to the outer labial fold, and in the shape of the vertical fins, and from the second species in the size of the gill-openings, and the position of the spiracle: from *P. collare* Ramsay and Ogilby, to which, on the whole, it perhaps most closely approaches, it is further separable mainly in having the nasal cirrus reaching the lip, the first gill-opening nearer to spiracle than to pectoral, and in the excavate posterior margins of the dorsals.

Specific name in allusion to the numerous brown spots.

Family ANGUILLIDAE

Genus **Anguilla** Shaw, 1803

Anguilla reinhardtii Steindachner

Anguilla reinhardtii Steindachner, *Sitzb. Akad. Wiss. Wien.* LV. 1. 1867. p. 15. figs. a-b. *Id.* McCulloch, *Aust. Mus. Mem.* V. I. 1929. p. 64.
Anguilla marginipinnis Macleay. *Proc. Linn. Soc. N.S.W.* VIII. 1883. p. 210.

Remarks. In a previous contribution (1934, p. 36) the position of this species on the Tasmanian list was discussed, and some notes were given on the dimensions attained by large individuals.

A large specimen (not preserved), obtained in the fluming of the municipal hydro-electric system between Duck Reach and the Power Station, near Launceston, on 16th April, 1934, yielded the following measurements. Total length 1658 mm., length to origin of dorsal 488 mm., length to middle of vent 705 mm., length to origin of anal 725 mm., length to origin of pectoral 208 mm., snout 42 mm., eye 17 mm., interorbital width 60 mm., girth 440 mm., weight (the day after capture) 33 lbs.

Lower jaw markedly projecting. Maxilla reaching to vertical of hinder margin of eye. Teeth typical. General colour brownish, almost black, above, lighter below. The $\frac{a-d}{t} \times 100$ value is 13·1, which is well above the average (10·72) and close to the maximum (13·2) value as determined by Schmidt (1928, p. 203).

Family SYNGNATHIDAE

Genus **Farlapiscis** Whitley, 1931

Farlapiscis breviceps (Peters)

Hippocampus breviceps Peters, *Monatsb. K. Pr. Akad. Wiss. Berlin* 1869 (1870). p. 710. *Id.* McCulloch, *Aust. Mus. Mem.* V. I. 1929. p. 95: and of authors generally to that date.
Farlapiscis breviceps Whitley, *Aust. Zool.* VI. 4. 1931. p. 313.

Record. In May, 1934, the Queen Victoria Museum obtained by exchange an example of this species (Reg. No. 984), secured at Denne's Point, Bruny Island, in April, 1934. The specimen is an adult male, measuring some 70 mm. in total length.

Remarks. Though this species is recorded by Johnston, both in his first list (1883, p. 135), where it is noted as 'common,' and in his second list (1891, p. 37), and is included in the lists of Lord (1923, p. 64) and Lord and Scott (1924, pp. 8 and 41), and is also credited to Tasmania by Waite and Hale (1921, p. 323), its range is recognized by McCulloch (1929, p. 95)—possibly through the lack of authenticated Tasmanian specimens—as extending only to South Australia, Western Australia, and New South Wales.

The present record serves to confirm the traditional inclusion of *Farlapiscis breviceps* in our faunal list.

Family HYPOPLECTRODIDAE

Genus **Nannoperca** Günther, 1861

Nannoperca tasmaniae (Johnston)

Microperca tasmaniae Johnston, *Pap. Proc. Roy. Soc. Tas.* 1882 (1883). p. 110.
Nannoperca tasmaniae McCulloch, *Aust. Mus. Mem.* V. II. 1929. p. 157.

Locality. In his description of the species Johnston observed, 'Abundant in the rivers of the South and North Esk. The young are found in large numbers in the shallow lagoons having connection with the rivers during some portion of the year.' No records of locality—indeed, few, if any, data based on actual material—other than Johnston's seem to have been published. During the last few years we have met with the species in several of the localities mentioned by Johnston, and, in view of its apparently restricted distribution, it is worthy of record that on 18th September, 1934, a specimen, 65 mm. in total length, was received at the Museum from Dunorlan—*i.e.*, from the Rubicon River—where it is said by the sender not previously to have been observed.

I hope on a future occasion to illustrate this species, and to discuss its relationships with *N. australis* (Günther), to which it is closely allied, and with which it has been proposed it should be associated (McCulloch and Waite, 1918, p. 45) in a subgenus *Nannoperca*.

Family SCORPIDAE

Genus **Scorpis** Cuvier and Valenciennes, 1832

Scorpis aequipinnis Richardson

Scorpis aequipinnis Richardson, *Zool. Voy. Erebus and Terror.* (*Fish*, 1848). p. 121. *Id.* McCulloch, *Rec. Aust. Mus.* XI. 7. 1917. p. 177. fig. 2. *Id.* McCulloch, *Aust. Mus. Mem.* V. II. p. 237.

Record. A specimen, 326 mm. in total length, from near George Town, was presented to the Queen Victoria Museum (Reg. No. FR814) by Mr. T. Tyler, fishmonger, Launceston, on 2nd December, 1933.

Remarks. First record of the species for Tasmania. I examined, however, another specimen from the same locality, which was not available for preservation, on 23rd November, 1933.

Johnston (1883, p. 111), citing Allport MS., admitted *S. georgianus* to his list, remarking, 'Rare. Not seen'; but included it without comment later (1891, p. 30): this species is listed by Lord (1923, p. 68), while Lord and Scott (1924, p. 65) observe 'occasionally taken on the Northern Coasts.'

In the Check-List McCulloch (1929, p. 237) gave the locality of *S. aequipinnis* as Western Australia only, and that of *S. georgianus* as Western Australia, Tasmania, and South Australia, though earlier, in reviewing the genus, he had admitted 'South and South-western Australia,' mentioning (1917, p. 178) a specimen from Adelaide in the Australian Museum. In the interval Waite (1921), who notices McCulloch's 1917 revision in his references, included both species in his South Australian catalogue—observe, however, Waite's convention concerning 'South Australia' (1921, p. 1)—illustrating only *S. aequipinnis* (fig. 172), and remarking regarding *S. georgianus* (p. 112), 'It is possible that this may prove to be the young of *S. aequipinnis*,' an observation suggested, it may be presumed, by the relatively more produced anterior dorsal and anal rays, and the somewhat larger eye of *S. georgianus*. In a supplement to the work cited Waite (1927, p. 230) states, concerning *Scorpis*, 'Our form, which is frequently banded, is referable to the type-species from

King George's Sound, Western Australia' (*i.e.*, *S. georgianus*), and deletes *S. aequipinnis* in favour of *S. georgianus*.

As a contribution to the vexed question of the distribution of these two species, I place on record below a short description (drawn up, to facilitate comparison, substantially in the form adopted in McCulloch's 1917 survey of the genus) of the Tasmanian specimen here identified as *S. aequipinnis*.

Description. D. IX, 27. A. III, 25. P. 18. V. I, 5. C. 17. Depth at the ventrals (111 mm.) 2·3 in length to hypural joint (254); head (64) 4·0 in same. Eye (16) 4·0, second dorsal ray (50) 1·3, second anal ray (50·5) 1·3, in head. Upper profile evenly convex above the eye, subequal throughout to lower profile. Mandible long, rather narrow, reaching to about one-fifth of orbital diameter beyond anterior orbital margin, its width (8·5) subequal to its distance from the eye (8). Outer row of teeth in each jaw much larger than the others. Scales small; 107 above lateral line from its origin to hypural joint; 17 between base of second dorsal ray and lateral line; 21 between base of pectoral and ventral spine. Dorsal and anal fins produced anteriorly, the anterior rays projecting beyond the middle rays, which are three-fourths of eye-diameter in height, and one and one-quarter times eye-diameter in total length, by a vertical distance subequal to the vertical median height of the fins. No dark cross-bands; uniform brownish black above, somewhat lighter below the lateral line.

Family GIRELLIDAE

Genus **Melambaphes** Günther, 1863

Melambaphes zebra (Richardson)

Crenidens zebra Richardson, *Zool. Voy. Erebus and Terror.* (*Fish*, 1846). p. 70.
Tephraeops zebra Waite, *Rec. S. Aust Mus.* II. 1. 1921. p. 114. fig. 115 (references and synonymy).
Melambaphes zebra McCulloch, *Aust. Mus. Mem.* V. 11. 1929. p. 240.

Record. Two specimens, 354 mm. and 357 mm. in total length, both from near George Town, were purchased by the Queen Victoria Museum (Reg. Nos. 985 a-b) from Mr. T. Tyler, fishmonger, Launceston, on 23rd November, 1933, and 7th December, 1933, respectively.

Remarks. According to McCulloch (1929, p. 240), this species has been recorded from all the Australian States except Tasmania and Queensland. A local record, however, appears to have been missed, as Lord (1925) noted it from the East Coast, remarking (p. 52), 'it is strange that its occurrence there should have been overlooked.' The present records from the north of the State are not, therefore, unexpected, and serve to confirm the inclusion of this species in the Tasmanian faunal list.

Family CLINIDAE

Genus **Clinus** Cuvier, 1816

Clinus johnstoni Saville-Kent

Clinus johnstoni Saville-Kent, *Rept. Fish. Dept. Tas.* p. 13. *Id.* Johnston, *Pap. Proc. Roy. Soc. Tas.* 1890 (1891). p. 33. *Id.* McCulloch, *Proc. Linn. Soc. N.S.W.* XL. 1915. p. 273. pl. XXXVII. fig. 2. *Id.* Lord, *Pap. Proc. Roy. Soc. Tas.* 1922 (1923). p. 70. *Id.* Lord and Scott, *Synop. Vert. Anim. Tas.* 1924. pp. 13 and 82. *Id.* McCulloch, *Aust Mus. Mem.* V. III. 1929. p. 349.

Previous Descriptions. Saville-Kent's description of the type, which was 'preserved alive for some time in the tanks of the fishery,' merely notes that it belongs to the genus *Clinus*, and 'differs from the single species, *C. despicillatus* [= *C. perspicillatus* Cuv. and Val.] hitherto taken in these waters, and which averages the length of 4 or 5 inches only, in its larger dimensions, 15 inches, in the great development of the nostril tentacles, and in other characters of specific value.' Johnston (1891, p. 33) recorded the fin-counts as follow:—D. 2–3: 32–33: 5. A. 2·25–26. V. 1·3; but gave no further details. The species was first fully described and figured by McCulloch (1915), whose account is based on two specimens, 227 mm. and 341 mm. in total length, in the Australian Museum, though he observes, 'I have also examined a still larger specimen in the Tasmanian Museum, which is possibly the type of the species.'

Material examined. An examination of a Tasmanian specimen of a *Clinus* (precise locality not recorded; probably Tamar Heads), 347 mm. in total length, in the Queen Victoria Museum (Reg. No. 887), which, in spite of its exhibiting some variation, seems clearly to be referable to *C. johnstoni* Saville-Kent, extends the recorded range of some of the radial formulae, and discloses some differences in proportion.

Fin-Counts and Proportions. D. 2, 33: 4 + 2. A. 2, 26. P. 16. V. 3. C. 10 + $\frac{1}{1}$

Length from tip of snout to end of bony operculum (72 mm.) 4·1, depth at origin of anal (69) 4·3, in length to hypural joint (296). Eye (11·5) 7·0, snout (15) 5·4, in head. Interorbital width (9·5) 1·2 in eye. Second dorsal spine (25·5) 3·2, first dorsal ray (41) 2·0, fourth last anal ray (39) 2·1, in head. Median rays of pectoral (50) 1·6, of ventral (44) 1·8, of caudal (51) 1·6, in head.

Description. The following minor additions to McCulloch's description may be noted. Approximate numbers of pores in the anterior horizontal, oblique, and posterior horizontal sections of the lateral line are 25, 6, and 27 respectively. Supraorbital tentacle has about seven lobes.

Variation. The chief variations from McCulloch's description are:—(*a*) the interesting presence of an extra ray in the dorsal, and the occurrence, as noted in the formula above, of differential spacing of the dorsal rays, not previously observed in the species; (*b*) additional ray in pectoral; (*c*) smaller eye (7·0, as against 5·2–6·1, in head); (*d*) shorter snout (5·4, as against 4·6–4·7, in head); (*e*) anal begins below 11th spine of second dorsal (about below 13th in McCulloch's figure). The specimen agrees with one of the two described by McCulloch in that the pectoral fails to attain to level of first anal spine (reaching about to vent), and with one of these two specimens in having lost all cross-bars on the body, no doubt as the result of preservation.

The 17th and 26th spines of the second dorsal are injured or malformed in the specimen, being only about two-thirds as long as their neighbours, and not reaching to the border of the membrane, which maintains an uninterrupted and normal line outside their tips.

Genus **Petraites** Ogilby, 1885

Petraites incertus McCulloch

Petraites incertus McCulloch, *Proc. Linn. Soc. N.S.W.* XL. 1915. p. 275. pl. XXXVII. fig. 3. *Id.* McCulloch, *Aust. Mus. Mem.* V. III. 1929. p. 350.

Material examined. Three specimens of a *Petraites*, 123 mm., 254 mm., and 211 mm. in total length, in the collection of the Queen Victoria Museum (Reg. Nos. 0840 a-c) are evidently referable to *P. incertus* McCulloch, the first two being from the type-locality of that species (River Tamar), the third, though known to be Tasmanian, being without precise locality-record. As no specimens other than the two syntypes appear to have been the subject of published description, it sems advisable to place on record the data afforded by an examination of the present examples. With the fin-counts and proportions, given below, the corresponding values for the syntypes, 205 mm. and 216 mm. long, are noted [in square brackets] for comparison.

Fin-Counts and Proportions. D. 3, 29: 4–5 [3, 29: 4]. A. 2, 24 [2, 23–24]. P. 11 [11]. V. 3 [3]. C. 9–9 + $\frac{1}{1}$ [9].

Head 3·0–3·5 [3·8–4·1], depth before anal 4·6–4·9 [4·3–4·9], in length to hypural. Eye 5·5–6·8 [5–5·1], snout 3·3–4·3 [3·7–3·8], in head. Interorbital width 1·5–1·8 [1·8–2·1] in eye. First dorsal spine 1·7–2·1 [1·6–1·9], first dorsal ray 1·8–2·0 [1·6], fourth last anal ray 1·9–2·7 [1·4–1·9], in head. Median pectoral ray 1·6–2·0 [1·3], median ventral ray 1·7–1·9 [1·4–1·5], median caudal ray 1·5–1·9 [1·3–1·6], in head.

Description. The following additions may be made to the original description. Approximate numbers of pores in the anterior horizontal, oblique, and posterior horizontal sections of the lateral line are 21–23, 4–5, 28–23 respectively. Anal begins below 11th spine of second dorsal. Inner ventral ray is 2·0–2·6, and outer 1·1, in median ray. Orbital tentacle, laid back, reaches to base of 1st spine, or to between bases of 1st and 2nd spines of first dorsal. One specimen affords some indications of the second dorsal and anal having been crossed by about six and about five oblique bars respectively, while the first dorsal has apparently borne some three or four subcircular blotches between the 1st and 2nd spines, five or six between the 2nd and 3rd spines, and two or three behind the 3rd spine.

Variation. Apart from the differences in fin-counts and proportions to which attention has been called above, the most noteworthy variation relates to the position of the first dorsal. This fin originates, as far as can be judged from the figure of one of the syntypes, virtually at (about $\frac{1}{10}$ of an eye-diameter behind) the posterior level of the eye, while in the present specimens it originates at from one-third to rather more than one-half an eye-diameter behind the orbital margin.

Affinities. These specimens would seem to indicate that the species is a well-defined one. As regards its relation to some of the early, imperfectly characterised species—a matter on which McCulloch expressed uncertainty, both implicitly in the specific name, and explicitly in his description—after a careful comparison of the specimens with the meagre published accounts of these, I can only say, with the author of the present species (p. 276), 'They do not wholly agree with any of the descriptions.'

Family ANTENNARIIDAE

Genus **Rhycherus** Ogilby, 1907

Rhycherus filamentosus (Castelnau)

(Plate V, fig. 2)

Chironectes filamentosus Castelnau, *Proc. Zool. Acclim. Soc. Vict.* I. 1872. p. 244.
Chironectes bifurcatus McCoy, *Prodr. Zool. Vict.* II. dec. XIII. 1886. p. 87. pl. CXXIII.
? *Rhycherus wildii* Ogilby, *Proc. Roy. Soc. Qld.* XX. 1907. p. 18.
Rhycherus filamentosus McCulloch and Waite, *Rec. S. Aust. Mus* I. 1. 1918. p. 70. pl. VI. fig. 3 and text-fig. 31. *Id.* McCulloch, *Aust. Mus. Mem.* V. III. 1929. p. 406.

Record. A specimen, 216 mm. in total length, caught at Tamar Heads by Mr. C. Andrews, was donated to the Queen Victoria Museum (Reg. No. FR 982) by Mr. T. Cannon, fishmonger, Launceston, on 2nd March, 1934.

First record for Tasmania. .

Remarks. The specimen agrees in general reasonably well with the Victorian individual described and figured by McCoy (1886) and with the South Australian examples dealt with by McCulloch and Waite (1918). Like these specimens it departs rather markedly from the description of *Rhycherus wildii* Ogilby, the haplotype of the genus, which Ogilby (1907, p. 19) explicitly states 'differs considerably from *Chironectes bifurcatus* McCoy,' but which McCulloch and Waite regard as conspecific with that form, and hence as synonymic with *R. filamentosus* (Castelnau)—a position maintained by McCulloch in the Check-List. Not having had an opportunity of examining the type of *R. wildii*, I cannot express a definite opinion on the matter, and can only comment that a comparison of the description by Ogilby with that by McCoy and that by McCulloch and Waite reveals some rather striking discrepancies, particularly in general proportions and in the form of the fins.

Compared with the continental examples described and figured by McCoy and by McCulloch and Waite, the present specimen exhibits the following differences.—(*a*) maxillary, instead of reaching to below hinder portion of eye, just fails to reach level of eye-tubercle; (*b*) illicium, instead of being shorter than, is two-thirds as long again as, naked supporting rod; (*c*) a yellowish blotch is present on the base of the membrane of the soft dorsal near the middle of the fin; (*d*) minor variations in proportion and colouration. The acquisition of further material may perhaps show that these variations entitle the Tasmanian form to subspecific distinction.

It is of interest to observe, as an indication of the perfection to which cryptic colouration is carried in this species, that the remarkable lichenoid blotches on the body occur also on the inside of the mouth—doubtless held open during 'angling'—where they form pearly white patches on the bluish grey tongue. Pale greenish lichenoid spots also delicately mottle much of the external surface of the pectoral.

SUMMARY

1. Some general observations are made on *Anguilla reinhardtii* Steindachner, *Nannoperca tasmaniae* (Johnston), *Clinus johnstoni* Saville-Kent, and *Petraites incertus* McCulloch.

2. Records are noted confirming the inclusion in the Tasmanian faunal list of *Farlapiscis breviceps* (Peters), and *Melambaphes zebra* (Richardson).

3. Additions to the Tasmanian faunal list comprise *Scorpis aequipinnis* Richardson, and *Rhycherus filamentosus* (Castelnau).

4. *Parascyllium multimaculatum*, sp. nov. (family Hemiscylliidae) is described and figured.

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EXPLANATION OF PLATE

Plate V—

Fig. 1.—*Parascyllium multimaculatum*, sp. nov. Holotype. Male. Locality, Tamar Heads, Tasmania. Total length 710 mm.

Fig. 2.—*Rhycherus filamentosus* (Castelnau). Locality, Tamar Heads, Tasmania. Total length, 216 mm.

Fig. 1.

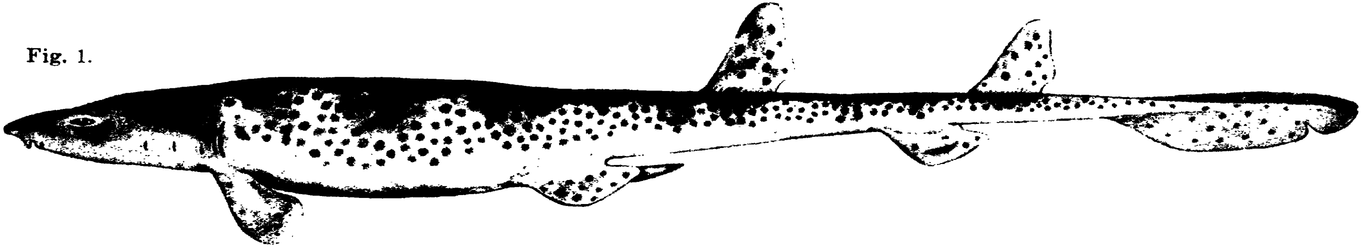

Fig. 2.

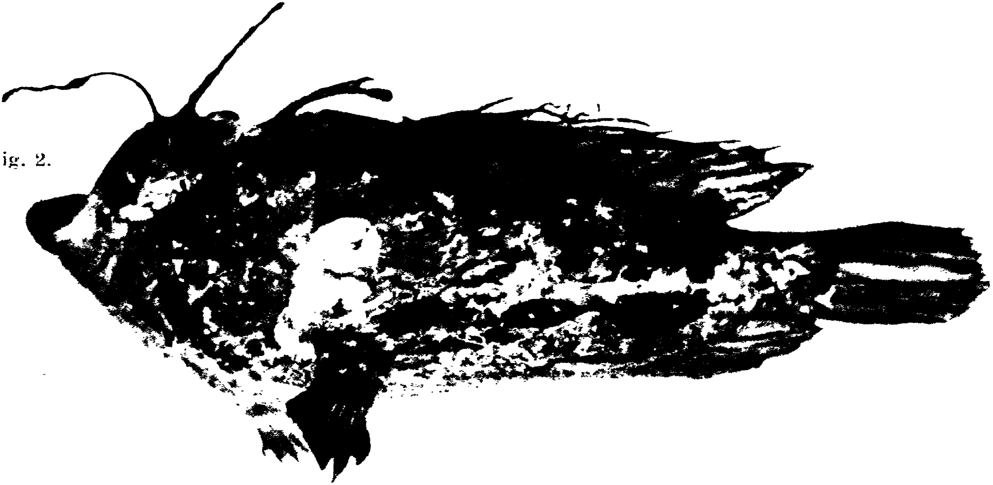

Fig. 1.—*Parascyllium multimaculatum*, sp. nov.

Fig. 2.—*Rhycherus filamentosus* (Castelnau)

[E.O.G.S. del.]

[Burrows photo.

Correlation of the Tasmanian Pleistocene Raised Beaches and River Terraces in Unglaciated Areas

By

A. N. Lewis, M.C., LL.D.

Two Plates and Three Text Figures

(Read 12th November, 1934)

This paper follows my attempted correlation of the Pleistocene glacial epochs (Lewis, 1934).

Further study of the raised beaches and river terraces in the Derwent, Coal, and Huon River valleys has made possible a tentative statement of the late Tertiary and Pleistocene succession in Southern Tasmania. The whole problem has by no means been solved, but sufficient data are forthcoming to warrant recording as a basis for future work. This is the phase of Tasmanian geology which has received the least attention in the past, and it was not until the effect of the waxing and waning of the four Pleistocene Ice Sheets on the level of the ocean was fully understood that the various apparently contradictory features of our coastal plains was decipherable.

The facts stated in this paper are entirely based on physiographic evidence. Certain palaeontological evidence is forthcoming from Northern Tasmania, and some information as to past happenings may be discoverable from a study of the petrological groupings of the pebbles in the various drifts, but no key in either direction has yet been found in Southern Tasmania. The association between the *Mirnyongs* (native kitchen middens) and the physiographic succession of river and marine terraces opens up an interesting field which has not yet been explored. This paper is intended to supply the geological background for further work by the anthropologist in this direction.

The remarkably accurate and detailed description of general post-Tertiary geology given by R. M. Johnston (1888) can hardly be amplified. W. H. Twelvetrees (1909) carried our knowledge very little further, and fully confirmed Johnston's general conclusions. Our present Government Geologist, Mr. P. B. Nye (1924) has given us the best general account of the geology of part of the area under discussion in this paper. He has divided the more recent sediments into Lower and Upper Tertiary, using the eruptive flows of olivine basalt as the dividing line. My observations confirm what Mr. Nye has written, except that it is quite possible that the whole of the Tertiary deposits he describes are Upper Tertiary (Pliocene). The division, however, is clear. The basalt appears to be referable to the more recent or upper basalt flows, and the date may not be further back than the opening of the Pleistocene period. Deposition of river gravels appears to have preceded the basaltic eruptions and to have continued, almost uninterruptedly, after the volcanic phase. All this, however, is open to some doubt at present, and in the present paper I start with the physiography as it appears after the last orogenic movements and the probably accompanying volcanic phase had ceased.

SUCCESSION OF TERTIARY AND PLEISTOCENE ROCKS IN SOUTHERN TASMANIA

(*a*) Leaf beds at One Tree Point, Pipeclay Bluff, and Geilston Bay, with river drift conglomerates and sandstones undifferentiated *inter se*. (Lower Tertiary of Nye.)

(*b*)—(i) Nephelite-Basanite of One Tree Point.

(ii) An eroded, unidentified porphyry-like rock at One Mile Hill, east of Bellerive.

(iii) Olivine basalts that occur in isolated patches at intervals seldom exceeding a mile along the valleys.

The above appears to be the sequence of this series. Perhaps the two first named represent the lower basalts and the last the upper basalts; perhaps some of the river drifts accumulated between these eruptions; but no evidence is as yet forthcoming on these points. The conglomerates that fringe Mt. Nelson appear to be river deposits brought from a distance. At One Tree Point they are overlain by Nephelite-Basanite.

(*c*) Newer conglomerates of immediately pre-Malannan age overlying the basalts and covering the old floors of the valleys to a height of 50-100 feet above present sea-level. The best occurrence of these is at Millbrook Rise, New Norfolk.

(*d*) Malanna phase, represented by river erosion to a depth of 150 feet below present sea-level in entrenched meanders.

(*e*) Malanna-Yolande interglacial phase, represented by the silting up of the Malannan troughs in the main and tributary valleys to a height of 50 feet above present sea-level, with raised beaches, inland wave terraces, and sand dunes and secondary river terraces in places.

(*f*) Yolande phase, represented by river erosion to a depth of 60 feet below present sea-level and the erosion of the present river channels, again in entrenched meanders.

(*g*) Yolande-Margaret interglacial phase, represented by a third series of terraces, raised beaches, etc., 5-15 feet above present sea-level.

(*h*) Margaret phase, during which the existing river courses were eroded. Data as to the depth to which the main channels were cut in the Yolande-Margaret silts is not forthcoming, but many tributary valleys were deepened 10-25 feet in the most recent delta and terrace silts.

(*i*) Post Margaret phase, represented by a progressive rise in sea-level, resulting in the silting up again of estuaries and bays and the drowning of certain lower tributaries.

All search in this area fails to disclose evidence of the missing fourth glacial phase. I still regard it as possible that land movements during the early Pleistocene have obscured records of such a phase here as well as in the glaciated areas. Otherwise, Southern Tasmania appears to have been a stable area since Malannan times.

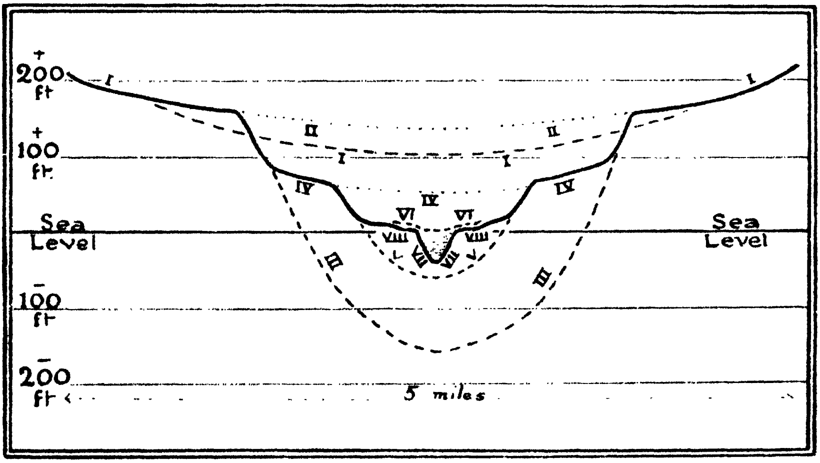

Fig. 1.—Generalized diagram, adapted from Derwent Valley features, illustrating comparative movements of strand-level with erosion and deposition features.

I—Late Tertiary valley.
II—Pre-Malannan silts.
III—Malannan trough.
IV—Malannan-Yolande silts.
V—Yolande trough.
VI—Yolande-Margaret silts.
VII—Margaret trough.
VIII—Post-Margaret silts.

THE DERWENT VALLEY

The pre-Malannan valley floor may be traced by remnants of consolidated clays, sands, and conglomerates standing at the fairly regular height of 50-100 feet above present sea-level. These are marked by the predominance of pebbles of quartzite and early Palaeozoic rocks, with an almost entire absence of dolerite pebbles. They are to be seen at Millbrook Rise, just below New Norfolk, and at several points on the northern bank of the river between the Rocks and Dromedary. They cap basalt flows between Bridgewater and Herds-man's Cove, and are to be found about a mile east of Old Beach post-office. They occur at Claremont, Glenorchy, and Lindisfarne. The regularity, both petrographically and physiographically, of these remnants indicates that they were once part of a continuous plain. They could not have been deposited under existing conditions.

The river, evidently flowing in gentle curving meanders, cut into these deposits to a depth of about 200 feet, as is shown by borings at Risdon and Cornelian Point. (See Journals and Papers of Parliament, Vol. CXIX, No. 2, and Text figs. 3 and 4.) It would be impossible for this trough to have been eroded as it is to a depth of 150 feet below sea-level unless the strand line had dropped to this extent. The information supplied by these bores is conclusive. The general physiography of the valley indicates that the trough was eroded subsequently to the deposits here termed pre-Malannan. It was probably at this period that the otherwise strange cliffs at the Rocks and Bedlam Walls were formed. The river clearly entrenched itself in pre-existing meanders in no clear relationship to the present minor details of the valley topography. Tributary valleys show a corresponding deepening—particularly the larger ones, such as the Lachlan and Jordan.

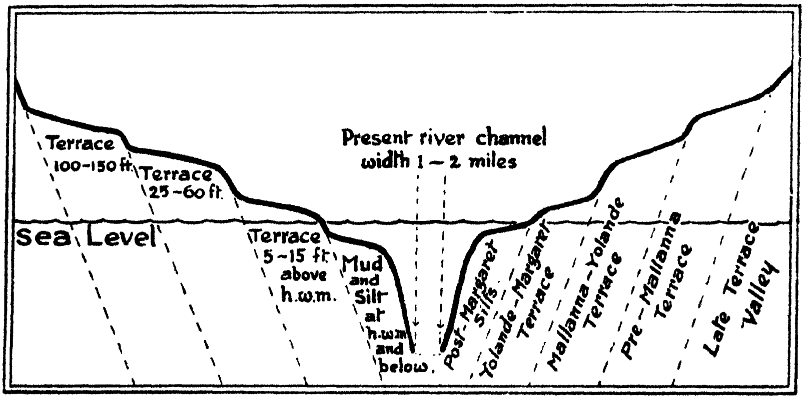

Fig. 2.—Diagram showing succession of terraces and periods of deposition.

The subsequent rise of strand-level produced newer river conglomerates, which outcrop along the road from Granton to New Norfolk and elsewhere on both sides of the Derwent. Tributary valleys were drowned to a height of 30 feet or so, and deltas were formed in them. This newer conglomerate consists almost entirely of dolerite and Permo-Carboniferous mudstone pebbles. In some places it is clearly hill wash and the product of small hill streams, but is roughly stratified at a height well above where it could lodge under present conditions. In the majority of localities, however, the evidence of well-worn pebbles and a considerable degree of stratification points to a deposition by the main river of materials brought from a considerable distance. These deposits have often been considerably eroded, and sometimes stand as the divide between more modern stream courses. The Malannan trough largely (perhaps entirely) silted up during this phase.

The next phase corresponds with the Yolande glaciation. The actual river valley during this phase is now submerged, and data are difficult to obtain, but the erosion of the deposits referable to the previous high-water phase was effected at this time, resulting in the many raised bluffs round which the road from Granton to New Norfolk winds. It also appears to me that the river channel was eroded to a depth of 30-60 feet below present sea-level. This formed virtually the present estuary, on the sides of which the subsequent terraces were deposited.

The Yolande-Margaret interglacial phase gave us the very distinct terraces standing now from high-water mark to 15 feet above high-water mark. The road from Granton to Sorell Creek winds along this terrace, and it is very noticeable under the Rocks where it is followed by the railway. It appears on both sides of Sorell Creek as a distinct separate terrace, and may be traced round the shore of most of the Derwent estuary, noticeably under Bedlam Walls, the cliffs at Lindisfarne, the Bluff at Bellerive, and the cliffs below the Shot Tower. Probably at this time the waters of the estuary extended to the obvious raised shore lines at the heads of several bays, notably at Kingston, where they extended inland to the present road bridge, and at Risdon Cove, where they extended to the old stone bridge or thereabouts.

The features imparted by the Margaret glacial phase of low water are also difficult to decipher except in tributary streams, but from Sorell Creek to the Iron Pot there is a definite old river channel meandering through the drowned estuary floor, a distinct river course to the vicinity of Hobart and then widening out. Its average depth below the general floor of the estuary is 20 feet. It is probably the result of erosion during this period. Throughout the area all streams have cut deep, straight-sided channels some 10 feet deep, or a little more in the newest terraces. This is such a uniform feature, particularly where the Yolande-Margaret terraces are well marked, that it must be due to more than local influences. The small entrenched meanders of such tributaries as the Lachlan, Sorell Creek, Risdon Creek, Kangaroo Rivulet, Rokeby Creek, and Brown's River, through their estuarine deltas of Yolande-Margaret interglacial age, provide the best examples, and the same feature may be seen in every creek and mountain stream through the area.

The last phase has been the steady drowning of the Derwent estuary and the mouths of its tributaries up to New Norfolk. This has resulted in a progressive silting in the course of the main river above Bridgewater and in the bays below. This silting is quite distinguishable from the previously formed terraces, which it continues but at a slightly lower level.

Two further features deserve passing mention. Across the estuary at its mouth westward from the Iron Pot is a marked bar. This appears to me to be, most probably, the flooded and eroded continuation of the line of sand dunes that may now be seen forming the connexion between the Sandford Peninsula and South Arm. It seems likely that during the maximum low-water phase of the Malanna period this was the real mouth of the river, and here sea-blown sand dunes accumulated as a bar. Perhaps the bar was complete with the waters of the Derwent passing down D'Entrecasteaux Channel. A

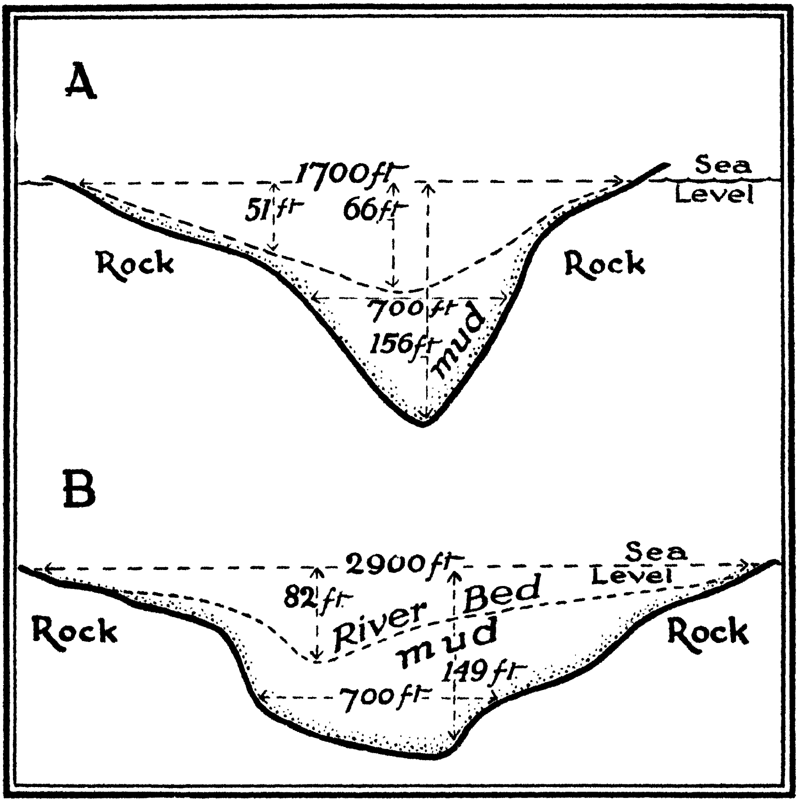

Fig. 8.—Sections through Derwent River (after diagrams in Journ. & Pap. Parlt. Tas. CXIX, No. 2).
A.—at Risdon. B.—at Cornelian Point.

second bar extends from Long Point to the beaches at Bellerive. Long Point is the residual of a line of sand dunes that probably marked the mouth of the river during the Yolande period of low water.

THE COAL RIVER - PITTWATER VALLEY

A similar series of features can be traced in this area. The older Tertiary deposits can be seen underlying basalt flows in the valley of the Coal just above Richmond. The pre-Malanna land surface stands at the height of the eroded basalt and over-lying gravels, about 50-100 feet above present sea-level. Subsequent events during the low-water periods are somewhat obscured by the fact that the Coal River does not appear to have eroded to the lowest sea-level, probably owing to its limited flow. During the Malanna phase the mouth of the river was probably in the vicinity of Lewisham, and the extensive sand-dune deposits of some antiquity that form the Milford Peninsula may be referable to this phase. The Coal River cut a considerable channel to an unknown depth south of Richmond, and it, with its tributaries, cut the channel through the present Pittwater. The effects of the second and third periods of high water are clearly decipherable in the double sets of terraces which occur throughout the river valley for several miles above and below Richmond. One, probably the Malanna-Yolande interglacial, was responsible for true raised beaches, which cover Milford, and may now be seen to a height of 20 feet or more on the road to the pine plantations and to a height of 10 feet surrounding Baralla Bay, and also for the line of old sand dunes that extend to the point terminated by Billy's Island, at the present mouth of the Coal River. Seven Mile Beach is a dune formation of new sand blown over older raised beach deposits at the mouth of the river as it stood during the lower water phases. Pittwater is the area of flooded river flats behind the line of dunes marking the true sea-board. The silting of the river mouths consequent on the latest rise in strand-level is most noticeable.

THE HUON VALLEY

In this area older Tertiary deposits of white quartzite gravels and conglomerates are well developed, principally at Huonville and Castle Forbes Bay, where they occur several hundred feet above sea-level. At Ranelagh wharf they outcrop under newer basalt. This basalt appears to have been eroded no lower than 50 feet above present sea-level. The same sequence of newer terraces is discernible—particularly for several miles along the Cygnet-road near Woodstock. The first of the series formed the fertile flats now 5-15 feet above river-level and, probably, Egg Island. The third series can be seen again as more recent silts. As with the other valleys, the successive troughs are difficult to ascertain, but appear to follow a similar succession as those in the Derwent Valley.

THE NORTH COAST

R. M. Johnston (1888) has given us the best account of this area yet published. He notes (p. 326) raised beaches, subordinate valleys within the main ones, river terraces, hillocks of consolidated sand dunes, and the oscillation of the strand-level. He records raised beaches at 100 feet above sea-level on Chappell Island (Furneaux Group). The Helicidae Sandstone group, a marine deposit standing at 100 feet above present sea-level on nearly all the islands of Bass Strait, may be definitely correlated with the pre-Malannan deposits of Southern Tasmania. This appears to represent the period of high water that initiated the Pleistocene age. The clay pan deposits underlying the Mowbray and other swamps of the extreme north-west coast, and which are, in places at any rate, composed of compacted deposits of calcareous marine worm-tubes, are also referable to the same period. Similar rocks are common on the Victorian and South Australian coasts.

The succeeding Malanna glacial phase must have left exposed a land bridge between Tasmania and Victoria even if there has been no subsequent subsidence. Johnston notes, although he did not identify, the next or Malanna-Yolande interglacial raised beaches. He states that they are invariably 40-50 feet above the present sea-level, and sometimes extend for a mile inland. To the same phase is referable the marked shore platform that skirts the whole of the north-west coast almost without a break. The towns of Ulverstone, Penguin, and Burnie are built on this platform, and it may be seen very clearly when standing on any coastal eminence. This is merely a wave-cut platform in the localities where spurs jut northward, but in the lower localities, as at Ulverstone and at the mouths of the Forth and Emu, fine sections of stratified conglomerates and raised beaches are exposed.

The final high-water phase (Yolande-Margaret inter-glacial) gave a second terrace, now standing a few feet above high-water mark. This is most noticeable from the Don to some miles westward of the Forth, but it may also be seen in many places round the coast.

The river valleys display terrace features with a general similarity to those in Southern Tasmania. The only published description bearing on this topic is to be found in Sir Edgeworth David's inaugural R. M. Johnston Lecture (David, 1924). The observations therein reported correspond very closely with those I have recorded in this paper from the Derwent Valley. In the next section I mention grounds for supposing a negative movement of the Bassian isthmus since Yolande-Margaret times. This movement is not apparent on the immediate sea-board, although it is reflected in the river valleys.

THE ANTIQUITY OF MAN IN TASMANIA

The segregation of the Pleistocene deposits as stated above provides us with a key to the problem as to the date of the arrival of the Tasmanian aborigines in the island. At present I am not in a position to give a final answer to this problem, and the present paper is intended merely as a starting point for investigations in this direction. In the first place, I think it must be accepted that the race emigrated by a more or less dry-land Bassian bridge. They may have been a preserved residual of a race which had previously spread all over the continent, or they may have been driven across by the superior Australian races. Their condition as described by actual observers indicates that the race was decadent, and they may originally have been able to build better rafts that those seen by the early explorers. Even so, it is very difficult to imagine a primitive people setting out for a land which lay over the horizon, and of the existence of which they must have been entirely ignorant. If they came by boats at all, the strand-line must have been sufficiently lower than it is at present to have allowed them to see the next land ahead, and their boats must have sufficed to have carried a sufficient number of people to maintain the race. From every point of view, the emigration must have occurred when Bass Strait was very different from what it is to-day.

It is clear that the strand-line dropped some 150 feet (25 fathoms) during Malannan times, some 50-60 feet (10 fathoms) during Yolande times, and some 10-25 feet during Margaret times (2-4 fathoms). Reference to the diagrams given by Dr. Fitz Noetling (1911, Plate I) shows that if the Bassian segment has remained at the level at which we see it at the present time, a sufficient land bridge could have only existed during Malannan times, and the subsequent glacial phases would not have lowered the surface of the ocean sufficiently to affect the position materially.

The absence of traces of the fourth ice phase constitutes a difficulty here, but the Malannan phase, which is probably to be correlated with the Mindel of the northern hemisphere or the Ross-Mindel interglacial, cannot be later than the Mindel. The Tasmanian people were a Negrito stock. It seems to be out of the question to suppose that members of this race could have penetrated to Southern Australia in Mindel times. (See Griffith Taylor, 1921, Plate I.) Should this prove to have been the case, it would present a remarkable case of homotaxis, it would indicate the way in which the aborigines crossed to Tasmania, and it would prove that the Bassian isthmus has been stable since Malannan times.

It is necessary to search elsewhere for evidence. As far as I have been able to see, the earliest mirnyongs lie on the raised beaches of the Yolande-Margaret interglacial period. Those I tentatively correlate with the Ross-Worm interglacial stage. It appears to me to be clear from the erosion below present sea-level of many of the coastal mirnyongs that some of these accumulated prior to the Margaret (Worm) glaciation. A very significant one may be seen on the New Norfolk road near the 13th milstone, and a repetition or continuation on the Bridgewater-Dromedary road a couple of miles from Bridgewater. These consist of shells of open-sea forms. Such molluscs could not exist in the estuary in its present form. They must have been gathered near where they are at present to be seen. They rest on the Yolande-Margaret terrace and are overlain by many feet of soil. It appears to me that the interglacial phases must have been accompanied by dry conditions, resulting in very little fresh water flowing into the estuary. The post-Margaret silts which now fringe the river could not then have existed. The water-level must have been somewhat higher, and the combination of all these factors resulted in a degree of salinity, even above Bridgewater, equal to that in the bays of the open coast. I consider these particular shell middens to have been eroded during the succeeding lower-water phase.

That would place this particular mirnyong in the Yolande-Margaret (Ross-Worm) interglacial phase, and this date corresponds with Griffith Taylor's for the emigration of the Tasmanians into Australia. It also corresponds with the age of the Talgai skull and the Doone flint (David, 1924). Estimates of time differ so greatly amongst various writers that it is difficult to give more than an approximation. Griffith Taylor would put the date, as far as our present knowledge goes, at which the aborigines accumulated the earliest mirnyongs that I have been able to identify at 200,000 years ago (Taylor, 1921). David makes this possibly 150,000 years, and Coleman would appear to date it as a somewhat more recent time in the neighbourhood of 100,000 years (Coleman, 1926). It does not appear to have been possibly later than the latter figure, extraordinary as this may seem.

To date, no shell mounds or flaked stones have been found earlier than the Yolande-Margaret interglacial terraces. The lowering of the sea-level during either the Yolande or the Margaret glacial phases could not have produced a land bridge to Victoria. That being so, the conclusion must be that there has been a negative eustatic movement of the Bassian isthmus since the aborigines emigrated to Tasmania. The evidence points to the fact that they migrated southward during a warm dry period. This indicates the possibility that the driving force may have been climatic, i.e., the southward movement of the central Australian desert belt, with the aborigines following the game which moved with the forest belts. It may have been a desert barrier which divided these people from the dingo-taming Australian races. All the evidence at present to hand therefore points to the separation of Tasmania, subsequent to the arrival of the aborigines, by earth movements across the Bassian land bridge which led to its eventual flooding. This trapped the aborigines here during the Margaret ice age. It is probable that at the time of their advent the fauna was somewhat different and more plentiful, and the rigorous conditions of the last phase of the ice age resulted in a steady deterioration of the race.

The gelogical evidence all points to a recent slight sinking or sagging of the Bassian terrain. It is a recognised modern earthquake zone, from which minor tremors are frequently reported. Also, the very marked rejuvenation of the rivers emptying into the Strait points to a recent subsidence rather than a post-glacial flooding. The problem of the date of the advent of the aborigines into Tasmania is so intimately connected with the problem of the formation of Bass Strait that the two must be studied together.

FUTURE STUDY

I have not been able to give close attention to more than a small fraction of river valleys and coastal estuaries which provide so rich a terrain for the study of these problems. We have a number of ardent anthropologists who devote much energy to the collection of worked stones from sand blows and middens. I hope I have opened up a new avenue for these workers, and I commend the devotion of some attention to the succession of Pleistocene terraces wherever they occur. A study of the relationship of these terraces to the mirnyongs, to ascertain the lowest gelogical horizon at which human life occurred, must prove more fruitful than the mere collection of specimens of culture, in themselves very uniform. Shell mounds are more likely to produce a key than isolated flints which may have become displaced, but all pebble drifts and terraces should be diligently searched for artifacts, as a vital clue may be found, as in the case of the Doone flint. The shell mounds themselves may be correlated to the phases of the Pleistocene period, and some change in culture may be traced when this correlation has been made. I have said sufficient to indicate a new field for anthropological study.

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EXPLANATION OF PLATES

PLATE VI—

Fig. 1.—Derwent Valley below Sorell Creek. Photo taken from site of pre Malanna terrace. The second (Malanna-Yolande interglacial) series is visible as the cleared paddock beyond the tree and road in the foreground and by the point beyond the river on left of picture.

The third (Yolande-Margaret interglacial) series is visible as the river flats bordering the river. At this point the river is now affected by tidal influences. Post-Margaret silts line the river below H.W.M., and an old channel 30 feet deep winds through these.

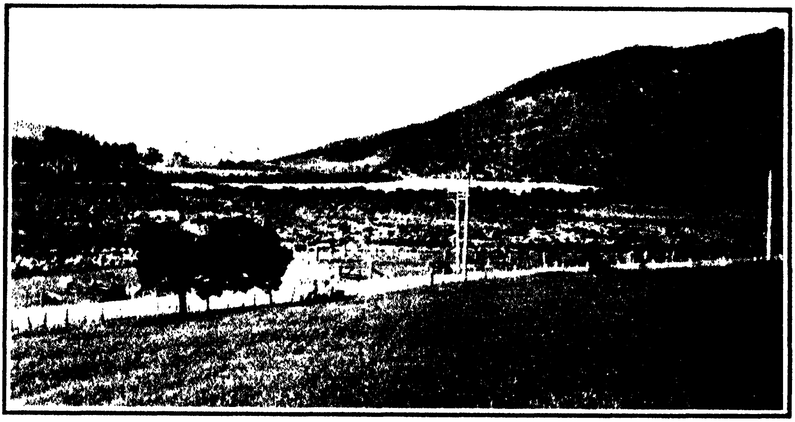
Fig. 2.—Terraces at Burnie, on the North Coast.

The hills in the background represent the old shore-line. The town of Wivenhoe is built on a second terrace, a section of which can be seen at the Emu Bridge in the right centre. A third terrace is visible to the seaward of this in the foreground and also at the termination of the point in the distance.

PLATE VII—Terraces in a tributary valley of the Derwent.

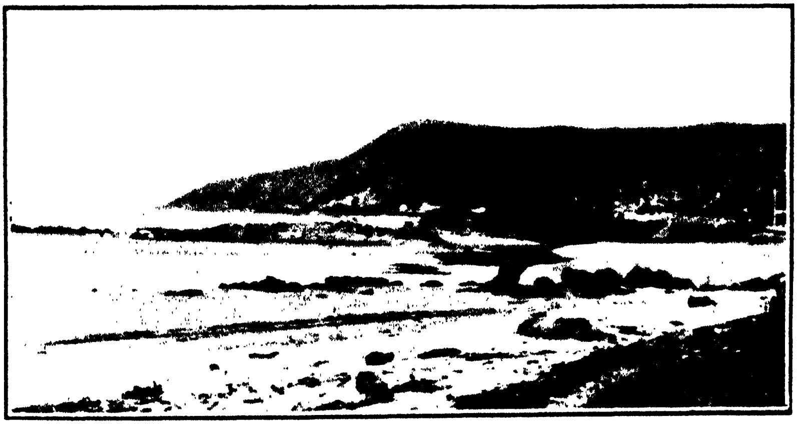
Fig. 1.—In the Lachlan Valley. The Millbrook Rise terrace can be seen under the farm buildings in the left middle distance. The next terrace formed by the silting up of the valley excavated in the Millbrook Rise terrace may be seen in the foreground. The present river has cut a channel in this, as seen in the foreground. The estuary of this channel ¼-mile below where photo taken has now been partly silted up.

Fig. 2.—Typical valley of tributary hill stream. The channel has been cut in the second (Malanna-Yolande) terrace, seen on the sides of the valley. The valley so excavated has been resilted up. In most cases this has again been dissected by recent streams.



[*A. N. Lewis Photo.*

Fig. 1. Derwent Valley below Sorell Creek.



[*A. N. Lewis Photo.*

Fig. 2.—Terraces at Burnie, N.W. Coast, Tasmania.

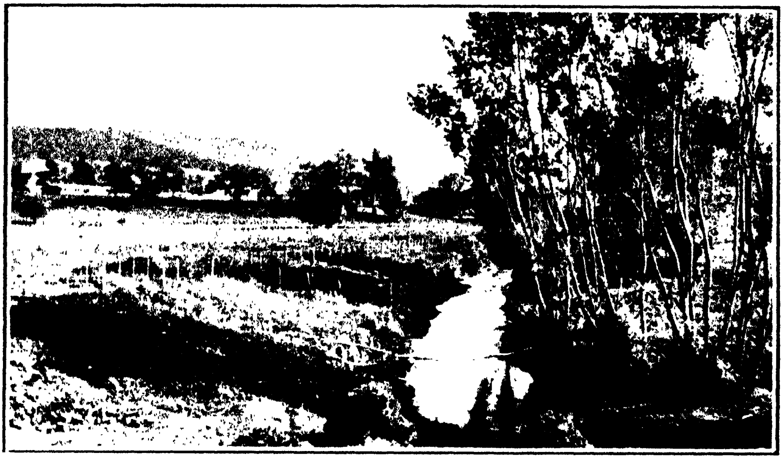


Fig. 1. Lachlan Valley, New Norfolk. A. N. *Lewis Photo*

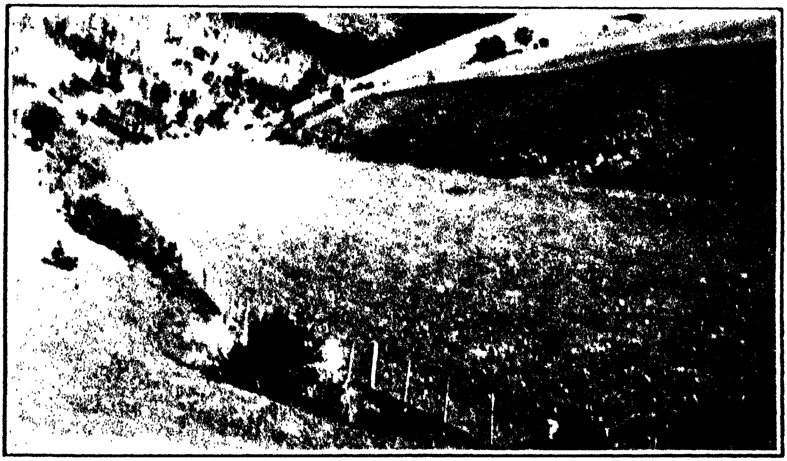


Fig. 2. Silted Tributary Valley. A. N. *Lewis Photo*

Glacial Features in the D'Entrecasteaux Valley

BY

A. N. LEWIS, M.C., LL.D.

AND

J. F. N. MURRAY, B.A.

In 1928 (Lewis, 1928) one of the present authors reported Silurian quartzite conglomerates in the valley of the D'Entrecasteaux River—Recherche Bay area—South-Western Tasmania. In so doing he was influenced by Twelvetrees (1915). Considering the matter more recently, it appeared that this occurrence might be of glacial origin. If this proved to be correct, the original site of these rocks must be westward of the La Perouse Range. An opportunity to visit this difficult locality has now presented itself. The rocks in question are undoubtedly of glacial origin, but they are Triassic grits, and not of Silurian age. No one can now be sure whether the series is the same as that reported by Twelvetrees, but from his very brief description this may be so. In any case, some further observations were made which are worth recording. This paper must be considered merely as an amplification of the previous account (Lewis, 1928).

Some four miles westward of Leprena, in the D'Entrecasteaux valley, and some two miles westward of the seaward limit of the button-grass plain in that locality, a peculiar button-grass covered and stream dissected spur runs northward from Leillateah to the present course of the river. This was previously described as consisting of quartzite conglomerate boulders (Lewis, 1928, p. 193). It is, in fact, an old moraine. On the surface lie boulders of considerable size. These consist of coarse quartzite conglomerates and grits, but of Triassic age, and evidently derived from the flanks of La Perouse, where a thin band of similar rocks exists (Lewis, 1924, p. 23). This spur is a distinctive feature, clearly discernible for miles around. The large white boulders are merely the largest erratics left on the surface after the finer and softer material has been washed away. The evidence that this is really an old moraine is—

(1) The assorted nature of the rocks, which are a jumble of stones of all sizes, from sand to the size of a large tent, and of conglomerates, grits, sandstones, shales of Triassic age, fossiliferous mudstones of Permo-Carboniferous age, and dolerite.

(2) The stratification planes of the grits, which are clearly visible, now appear pointing to every point of the compass and at every angle.

(3) The grits when *in situ* only occupy a vertical range of 50-100 feet, while here they are strewn over a vertical height of nearly 1000 feet.

(4) The ridge extends into the main valley in such a way that it cannot be an erosion feature, and is dissected by streams that traverse its long axis in a way which shows that they cannot have been responsible for it.

(5) The degree of dissection compared with that of the neighbouring hillsides shows that it is of different topographic origin from the main valley.

(6) The rubbly nature can be seen over a vertical range of nearly 1000 feet. We see here a very considerable ancient moraine lying across a previously eroded glacial valley, and itself eroded by a newer glacier which has superimposed its moraine upon the older one in rather a peculiar manner.

The whole D'Entrecasteaux valley appears to have been filled with ice at some time. It could not have been eroded as we see it at present by the existing river; its spurs have been shorn by a glacier, and there is evidence that ice reached sea-level at Leprena, where quartz pebbles and basalt boulders indicate an eroded moraine. Subsequently, a glacier deposited the moraine already described as a barrier across the valley. This may originally have stood 800-1000 feet above the valley floor. This moraine was then eroded to about 400 feet above sea-level on the northern side of the valley, and ice again extended to at least the eastern extremity of the button-grass plain, some two miles below the old moraine, and deposited a newer moraine in the valley occupied by it. Subsequently again, ice invaded the highlands of La Perouse, two miles further westward, and gave us the mountain tarns already fully described (Lewis, 1924). The lastmentioned glaciers did not reach the Leprena Plain. The glacier which flowed down the valley eroded in the older moraine reached at least to 300 feet above sea-level, but did not fill the valley as previously eroded. In its own valley it left a considerable area of terminal moraine, now visible as the button-grass plain of the D'Entrecasteaux valley, and distinguished by frequent small boulders of dolerite, particularly where clumps of trees are now growing.

This is the first recorded instance of a Pleistocene moraine definitely superimposed on an earlier moraine of the same period. The appearance of this feature, however, is very different from what was expected. We see here a Pleistocene moraine which must at one time have formed a wall some 800-1000 feet high and about a mile broad across a valley which had previously been impressed with typically glacial characteristics. After the disappearance of the ice which deposited this moraine, it was breached at one side, and eroded below the present level of the valley floor. During a succeeding glacial phase of the Pleistocene period a new glacier passed through this breach, widening it considerably, and, eventually, deposited its terminal moraine for four miles or more over its valley. This material is of unknown depth, but it must be shallow in comparison to the huge older moraine. It extends along the present valley both below and above the older moraine, and is definitely superimposed on the old transverse deposit where it crosses it.

The sequence of events during the Pleistocene ice age appears to have been as follows. The period was initiated before the final uplift of the La Perouse Range when the area was a dissected peneplain, with Leillateah and Sugar Loaf Range representing the general level of the higher elevations. The summits of La Perouse, Pindar's Peak, Mts. Wyllie, &c., and Precipitous Bluff group probably stood at much the same general level (2500 feet). During the first discernible glacial phase (Malanna) an ice-cap covered the plateau, and extended in very considerable glaciers to sea-level down the D'Entrecasteaux, Catamaran, and Lune valleys. The terminal areas of the glaciers are now flooded. Ice must have been over 1000 feet in depth, and must have entirely filled the valleys. During the recession of the glacier in the D'Entrecasteaux valley the transverse grit moraine was deposited. The uplift of the La Perouse group of mountains to their present height (4000 feet) occurred during the succeeding (Malanna-Yolande) interglacial phase. At this time the streams flowing over the new escarpment wore the present gorges and deepened troughs in the older glacial valleys. The Yolande glaciers succeeded, and were responsible for the cirques described by Lewis (1924). The Margaret phase was responsible for the mountain tarns and superimposed cirques also described in the lastmentioned paper.

Two other possibilities exist, but the evidence is too doubtful to permit of either being advanced as certainties until confirmed by observations elsewhere. The transverse grit moraine has definitely been deposited in a previously eroded glacial valley. This erosion may have been due to the same glacier as deposited the moraine, that event having occurred towards the end of its recession phase. On the other hand, we may have here evidence of two separate glacial phases. The second possibility is that the glacier which was responsible for the superimposed moraine descended, not from the cirques at present so clearly defined on the sides of La Perouse, but from a point half-way down the three valleys of the present D'Entrecasteaux River. Here there is now a marked topographical break, a sharp waterworn gorge indicating a drop of about 1000 feet with the glaciated valley below and the cirques and glaciated valleys above. This feature may indicate two glacial phases between that responsible for the transverse grit moraine and the Margaret features on the mountain tops. Lewis (1924, Plate VI. fig. 1) shows a view from the top of the Yolande cirque, with the glacial valley extending towards Leillateah in the centre of the picture. At that point the valley turns half left and drops rapidly. 1000 feet below are found the traces of the glacier which was responsible for the superimposed moraine. (In the same paper Plate VI, fig. 2, shows a Margaret cirque superimposed on the Yolande cirque shown in fig. 1, the edge of which is visible on the left of fig. 2.) The break in the glacial valleys as here described may be due to post-glacial (or post-Yolande) river erosion at the point which the streams fall over the main fault scarp of the range, or it may represent the scarp of a post-Yolande uplift breaking the continuity of the Yolande glacial valley, or it may represent the results of two distinct ice phases.

It appears, therefore, that this area shows a topography which would well conform to a landscape moulded by four distinct Pleistocene glaciations. But at present we do not regard the evidence so far available as conclusive proof of the existence in this part of Tasmania of four Pleistocene glacial periods, and confirmation must still be sought elsewhere. The evidence in the D'Entrecasteaux valley is quite consistent with the occurrence of only three glacial phases. For the present we assign to the transverse grit moraine the tentative appellation of "The D'Entrecasteaux Phase," leaving it to future investigation to determine whether it should be correlated with the Malanna glacial phase or whether it represents the missing fourth glaciation.

REFERENCES.

TWELVETREES. W. H. 1915—The Catamaran, etc., Coal Fields. *Geol. Survey Tas. Bul.* No. 20.

LEWIS, A. N. 1925—Notes on a Geological Reconnaissance of Mt. La Perouse Range. *P. & P. Roy. Soc. Tas.* 1924 (1925), p. 9.

———— 1928—A further account of the Geology of the Catamaran Coal Field. *P. & P. Roy. Soc. Tas.* 1927 (1928), p. 188.

The Royal Society of Tasmania

Abstract of Proceedings
1934

22ND JANUARY, 1934

A special meeting was held in the Society's Rooms, the President, His Excellency Sir Ernest Clark, K.C.B., C.B.E., presiding.

Professor W. A. Osborne, M.B., B.Ch., F.A.C.S., delivered a lecture entitled 'Success and Failure in Animal Design.'

12TH MARCH, 1934

Annual Meeting

The Annual Meeting was held at the Society's Rooms, Tasmanian Museum, on this date, the President, His Excellency Sir Ernest Clark, K.C.B., C.B.E., presiding.

Under Rule 3 His Excellency the President nominated the following two Vice-Presidents:—Mr. W. H. Clemes and Mr. E. E. Unwin.

The following were elected as members of the Council for 1934:—Mr. S. Angel, Dr. A. H. Clarke, Mr. W. H. Clemes, Dr. W. L. Crowther, Mr. E. T. Emmett, Mr. V. V. Hickman, Dr. A. N. Lewis, Mr. E. E. Unwin, Dr. F. E. Ward.

Mr. Walter E. Taylor was appointed Hon. Auditor.

The following motion was proposed by Dr. Crowther, seconded by Sir Elliott Lewis, and carried:—

> 'That Rule 17 be amended by deleting the words "not resident in Tasmania" from the first line thereof.'

The following motion was proposed by Dr. Crowther, seconded from the Chair, and carried:—

> 'That in accordance with the recommendation of the Council, and in terms of Rule 41e (5), the Society's Medal be awarded to H. H. Scott, Esq., Curator of the Queen Victoria Museum, Launceston.'

The following members were elected:—Col. J. L. Whitham, Mr. Donald Martin.

Mr. S. W. Steane gave an illustrated lecture on 'Bush Fires.'

9TH APRIL, 1934

A meeting was held in the Society's Rooms, Mr. W. H. Clemes presiding.

The Chairman reported that the Council had made the following appointments for the year:—

Chairman: Mr. W. H. Clemes.

Secretary: Dr. Joseph Pearson.

Treasurer: Mr. S. Angel.

Trustees of the Museum: Mr. W. H. Clemes, Dr. W. L. Crowther, Mr. S. Angel, Dr. A. N. Lewis, Mr. E. E. Unwin, Mr. V. V. Hickman.

It was proposed by Dr. Lewis, seconded by Dr. Crowther, and carried, that Mr. L. Rodway be elected an Honorary Member of the Society under Rule 17.

The following members were elected:—Mrs. Clive Lord, Mr. C. E. H. Ferguson, Mr. N. Oldham.

The Chairman presented the Royal Society's Medal to Mr. H. H. Scott. Mr. Unwin, Dr. Crowther, and Mr. Hickman testified to the valuable work which Mr. Scott had done as Curator of the Queen Victoria Museum, Launceston.

Mr. Scott delivered a lecture entitled:

Part 1: 'Mr. Clive E. Lord, my Collaborator.'
Part 2: 'The Australian Marsupial Titanotheres.'

30TH MAY, 1934

The R. M. Johnston Memorial Meeting was held at the Society's Rooms, the President, His Excellency Sir Ernest Clark, K.C.B., C.B.E., presiding.

Mrs. G. O. Smith was elected a member.

His Excellency presented the R. M. Johnston Memorial Medal to Professor W. J. Dakin, Professor of Zoology, University of Sydney, who afterwards delivered the fourth R. M. Johnston Memorial Lecture, entitled 'Biological Science and Marine Fisheries.'

After the lecture a Conversazione was held in the Art Gallery.

11TH JUNE, 1934

A meeting was held in the Society's Rooms, the President, His Excellency Sir Ernest Clark, K.C.B., C.B.E., presiding.

The following members were elected:—Professor K. Shatwell, Mr. R. G. Brett, Mr. R. F. Turner, Mr. D. M. Urquhart, Mr. B. C. Lovett.

Dr. Joseph Pearson delivered an illustrated lecture on 'The Wanderings of Animals.'

9TH JULY, 1934

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

The following members were elected:—Mrs. R. I. Courthope, Mr. Charles Wolfhagen, Dr. F. Fay.

Mr. R. W. Legge, Hon. Curator, Ethnological Section, Tasmanian Museum, read a paper entitled 'Notes on some of the principal Aboriginal Camping Grounds and Middens of the East Coast of Tasmania, with remarks upon their Stone-culture and Food-supply,' and showed slides illustrating the paper.

13TH AUGUST, 1934

A meeting was held at the Society's Rooms, the President, His Excellency the Governor, presiding.

Dr. Joseph Pearson gave some notes on *Caperea marginata,* the pygmy right whale.

Mr. John Reynolds delivered an illustrated lecture entitled 'The Anti-Transportation Movement in Tasmania, 1840-1853.'

10TH SEPTEMBER, 1934.

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

The following members were elected:—Mrs. M. Roberts, Mrs. L. Wettenhall, Mr. L. A. Triebel.

Dr. A. N. Lewis proposed the following resolution regarding the death of Sir T. W. Edgeworth David:—

> 'The Royal Society of Tasmania records with deep regret the death of Sir T. W. Edgeworth David, K.B.E., C.M.G., D.S.O., D.Sc., B.A., F.R.S., Emeritus Professor of Geology, University of Sydney, and the senior honorary member of this Society, and places on record its appreciation of a long life of outstanding service for science in Australia, and many acts of assistance rendered to this Society.'

The resolution was seconded by Mr. W. H. Clemes and supported by Mr. W. M. Carne, all present signifying their approval by standing. A copy of the resolution was forwarded to Lady David.

Miss J. A. Fletcher delivered an illustrated lecture entitled 'Field Experiences Amongst Some of Our Birds.'

8TH OCTOBER, 1934

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

Captain D. Colbron Pearse, M.C., Hon. Curator of the Art Gallery, delivered an ilustrated lecture entitled 'Whither Art?'

12TH NOVEMBER, 1934

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

The following members were elected:—Dr. J. Wunderly, Mr. W. Harris.

The following papers were submitted for publication, and referred to the Standing Committee:—

(*a*) 'Correlation of the Tasmanian Pleistocene Raised Beaches and River Terraces in Unglaciated Areas,' by A. N. Lewis, M.C., LL.D.

(*b*) 'On a New Genus of Fishes of the Family Galaxiidae,' by E. O. G. Scott, B.Sc.

(*c*) 'Notes on the Gobies Recorded from Tasmania: with Description of a New Genus,' by E. O. G. Scott, B.Sc.

Mr. E. T. Emmett delivered an illustrated lecture entitled 'Richmond and its History.'

Northern Branch

Annual Report

The Northern Branch experienced a successful year. Monthly meetings were held during the usual session from May to September, inclusive, and the Council met on seven occasions.

With the exception of the August meeting, which took place at the Launceston Technical College, both monthly meetings and Council meetings were held at the Public Library.

2ND MAY, 1934

Annual Meeting

Mr. W. R. Rolph presided. The following were elected as members of the Branch Council for 1934:—Mr. W. R. Rolph (Chairman), Hon. Tasman Shields, Messrs. R. S. Padman, F. Heyward, A. L. Meston, J. E. Heritage, D. V. Allen, F. Smithies, J. R. Forward, E. O. G. Scott (Secretary). The statement of accounts, which disclosed a credit balance of £31 3s. 0d., was read and adopted.

Illustrated lecture: 'Seven Years in the Far East,' by Mr. John A. Brailsford, B.A.

18TH JUNE, 1934

Mr. W. R. Rolph presided. Illustrated lecture: 'Through Trackless Wilds, A Journey from Queenstown to Cradle Mountain *via* Eldon Bluff, Canning Gorge, and Pelion Range,' by Mr. F. Smithies.

16TH JULY, 1934

Mr. W. R. Rolph presided. Illustrated lecture: 'Notes on the Museum Historical Collection,' by Mr. H. H. Scott. Paper: 'On a New Genus of Fishes of the Family Galaxiidae,' by Mr. E. O. G. Scott.

6TH AUGUST, 1934

Mr. A. L. Meston presided. Illustrated lecture: 'Atmospheric Electricity,' by Mr. A. H. Masters.

26TH SEPTEMBER, 1934

Mr. W. R. Rolph presided. Illustrated address, and paper: 'Some Aspects of the Art of Implement-making among the Tasmanian Aboriginals,' by Mr. F. Heyward. Paper: 'Notes on the Gobies Recorded from Tasmania: with Description of a New Genus,' by Mr. E. O. G. Scott.

COUNCIL MEETINGS.

Meetings of the Council were held on 13th April, 28th May, 28th June, 23rd July, 28th August, and 30th September, 1934.

Walter E. Shimmins, Government Printer, Tasmania.

PAPERS & PROCEEDINGS

OF

THE ROYAL SOCIETY OF TASMANIA

FOR THE YEAR

1935

EDITED BY

Joseph Pearson, D.Sc. (Manc.), D.Sc. (Liverpool), F.R.S.E., F.L.S.

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1936

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Papers and Proceedings, 1935

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Our Pulsating World

The Influence of Earth Movements on Human Development[1]

By

A. N. LEWIS, M.C., LL.D.

(Portion of a lecture delivered at the presentation of the Medal of the Royal Society of Tasmania to the author)

GEOPHILOSOPHY

It is very usual for people to say 'Things are not what they used to be—even the climate is changing.' Of course it is. Everything is changing. Change is the order of nature. Nevertheless, change and development in the vegetable and animal kingdom are very largely the result of changes on the face of the earth. This change is so gradual as to be imperceptible to human senses, but what we call 'the solid earth' is really a pulsating body, growing, discarding, developing almost like a living thing, and the results of each period of development lie around us, if only we will look.

We can now see an underlying principle or guiding influence emerging from the bewildering discoveries of science. This is the nature of the Earth itself—the mother of all living things, and, if we are to lead a really full life, we must be able to picture the Earth in its relationships to ourselves. After all, is this not true philosophy—the science of being—for out of the Earth all things have their being. Looking beyond individuals to species and wider groups of living things, we can see that they have not *grown*, but rather have been *brought up*. If our philosophy stops short of bestowing a consciousness on the Earth, that is only because our ideas are restricted by language. The result we see around us is in no way different from what it would be were we to accept the Earth as a conscious individuality. The conscious direction given by the human mind is, after all, a physical phenomenon, the result of influences dating back for hundreds of millions of years. The control of life by the Earth is also a physical phenomenon emanating from the same influences and, ultimately, the same force as the human mind. If we are to live fully we must have a philosophy of life. To serve us truly, our philosophy must be based on truth. The knowledge of the being of the world as a planet—what I have called *Geophilosophy*—must form the basis of our personal philosophy of our own life.

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[1] This lecture may be regarded as a summary of present geographical knowledge for the benefit of Tasmanian students, rather than as an original contribution to scientific knowledge of any general interest beyond Tasmania.—A.N.L.

Yet how much does the average person care? Of the thousands who daily look at Mount Wellington from our city streets, how many ever think, *how, when, why,* it stands as we see it. It is a real tragedy that there are not ten people amongst those who have ever seen it who have tried to fathom the riddle of Hobart's Sphinx. How much more true is this of our conception of the world as a whole. Unless you can hold the Earth in your hand and understand it as the living, pulsating, and dominating thing it is—can you call yourself a philosopher? The first lesson of science is proportion. When you can comprehend the sun as an infinitesimal atom of the universe rushing through space at 200,000 miles an hour, now twenty-five billion miles from its nearest neighbour, but nevertheless a member of the larger atom of creation—when you can comprehend the influence of the Earth, a minor planet upon the atoms which in their organized existence make up the microscopic creatures which live on its surface—then you will have no unduly exaggerated notion of the importance of your own daily troubles.

THE EARTH

Before we can form a reasonable appreciation of events on the surface of the earth, we must have an accurate idea of the nature of our earth as a planet. Modern science has gone a long way towards providing this. In the first place, the world is not a thin crust adjusting itself to a cooling interior. We have learnt much since Kelvin used the simile of the baked apple. For one reason, amongst many, solid rock (unlike ice) sinks in its molten equivalent, and, in cooling, the core of the earth solidified first. We must regard the earth as a mass of rock groups of varying nature, with the heaviest at the core, all under enormous pressure, which increases with depth, and all mutually supporting each other in a condition of adjustment, held together by a definite attraction and by great pressure from outside.

The mass of the earth is composed of a few common and many rare elements, which combined in the original cooling to form definite minerals. The minerals which consolidated first and heavy minerals consolidating somewhat later tended to congregate as a core. The earth in this way is now seen to consist of concentric rings of matter which increase in density inwards. The inner core consists of a substance resembling nickel steel (called by Suess *Nife*), with gold, platinum, and other heavy metallic elements. Outside this is a ring of iron silicates *(Sife)*, divided into eclogite and pallassite—our heaviest known rocks. Next come the ferro-magnesium silicates, or basalt rocks *(Sima)*, and, last of all, the alumina silicates, or granite rocks *(Sial)*. It will be noticed from Fig. 1 that the *Sial* is not continuous. Over the Atlantic it is very thin, and it is ruptured over the Pacific, Indian, Arctic, and Southern Oceans.

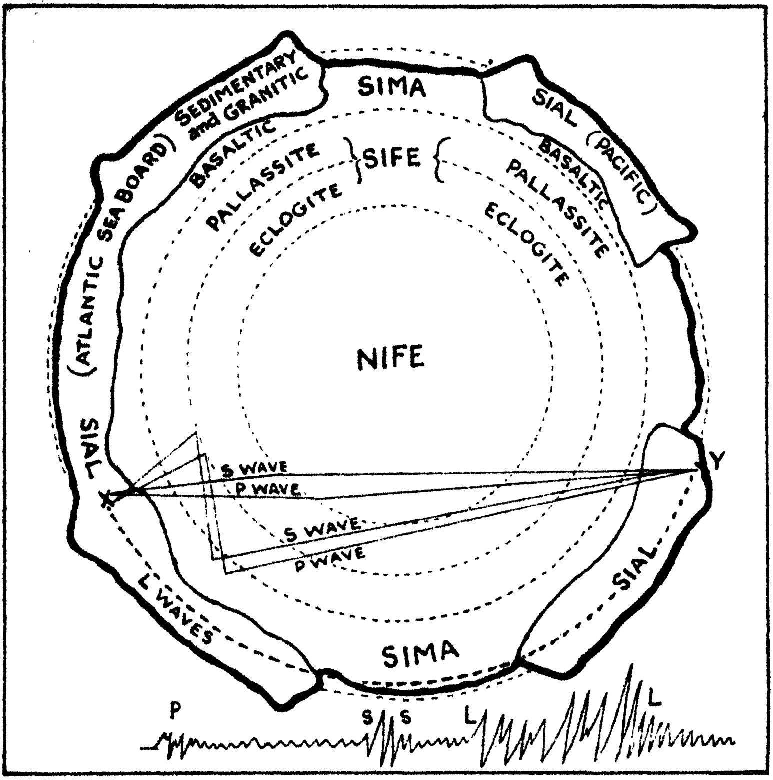

Fig. 1.—Diagrammatic Representation of the Interior of the Earth. This shows the density zoning from the nickel-iron core (s.g. 7·5) to the basaltic layer (s.g. 3·5), with the light acid or granitic layer (s.g. 2·5) forming the land masses 'floating' in the basaltic layer. The Atlantic Ocean covers a depression in the granitic layer, and the other oceans cover gaps in the layer, having floors of the basaltic layer.

(Note.—The diagram is not intended to represent the reflexion and refraction angles of the earthquake waves, which are greatly exaggerated.)

The study of the behaviour of the seismograph when recording major earthquakes has provided a means whereby the nature of the interior of the earth may be studied. It is very noticeable that the instrument commences its record by a number of short, sharp vibrations (*P* waves). After an appreciable time a few waves of greater intensity are recorded (*S* waves). These gradually decrease until they are replaced by waves of maximum intensity (*L* waves), which reach a climax, and then decrease regularly until the instrument ceases to record. The earthquake shock produces wave motions similar to any other wave, and when such an impulse passes from one medium to another of a different density the original wave is split, portion being reflected back into the original medium, and portion passes to the new medium, but with a slight change in direction (provided, in both cases, the angle at which the wave meets the dividing line permits this). The *P* waves are those which pass direct from the epicentre of the earthquake *X* to the instrument *Y*. The *S* waves are reflected waves, of which there may be many, as several media are traversed. The *L* waves are those which travel round the circumference of the earth. When the epicentre has been located, and the distance thence to the instrument has been accurately measured, the time interval between the reception of the *P*, *S*, and *L* waves provides a means of testing the varying density of the rock through which the waves have passed. The rate of passage is constant, and is now known with great accuracy, and from the results of extensive researches it has been possible to determine the density, and consequently the nature, of the rocks composing the interior of the earth.

It is well established that the interior cores are very solid, more so than the best steel. They are certainly at a high temperature, so hot that they would fly into gases if at the surface, but they are under such compression that they maintain their rigidity. However, if the pressure is released, they will fuse, and they will yield to the slightest variation of pressure. The position is that the earth is only stable while the pressure from all parts of the surface on the interior is the same. When this varies, the interior yields, with the results to be described later. Thus, the lighter *Sial* may be regarded as floating on the *Sima*, somewhat as icebergs float on water. It cannot sink, as it is lighter, but it can squeeze portion of the *Sima* out between spaces in the disjointed blocks of *Sial*.

These blocks of *Sial* are the continents, and the spaces between them are filled with the lightest and most fluid constituent of the earth (water). These spaces represent the oceans, except the Atlantic, which is a deep trough in the *Sial*. The framework, or shields, of these continents were formed from the original *Sial* masses on the original cooling of the world. All that primordial material has now disappeared, but we can trace where it originally stood. This was the position when the world had first cooled sufficiently to allow water to remain on the surface. The surface was then covered by some 12 to 14 blocks of differing density, but all exerting an equal pressure on the interior, the difference in density being compensated by difference in height above the average surface. These blocks therefore interlocked and mutually supported each other, much as the stones of an arch.

But from the very first another factor was at work which tended to upset this adjustment—isostatic adjustment as it is called.

That factor was erosion. All day and every day the influence of weather and running streams is at work on every part of the surface of the globe which is not protected by the sea. The effect of this is that the lighter segments are continually being worn away and made lighter. All this eroded material is carried out to sea and deposited on the heavier segments, which are continually being made heavier. In the course of time this upsets the adjustment. The heavier segments cannot sink, in the normal sense of the term, because they are supported by still denser layers below, but they exert a cumulatively greater pressure on the plastic interior, and squeeze underlying material in the direction of least resistance—under the lighter segment alongside. That imparts a constant upward movement to the land, which in turn adds erosive power to its streams, and increases the load which is bearing down the neighbouring ocean floor. So we have a constant cycle of movement, as shown in Fig. 2.

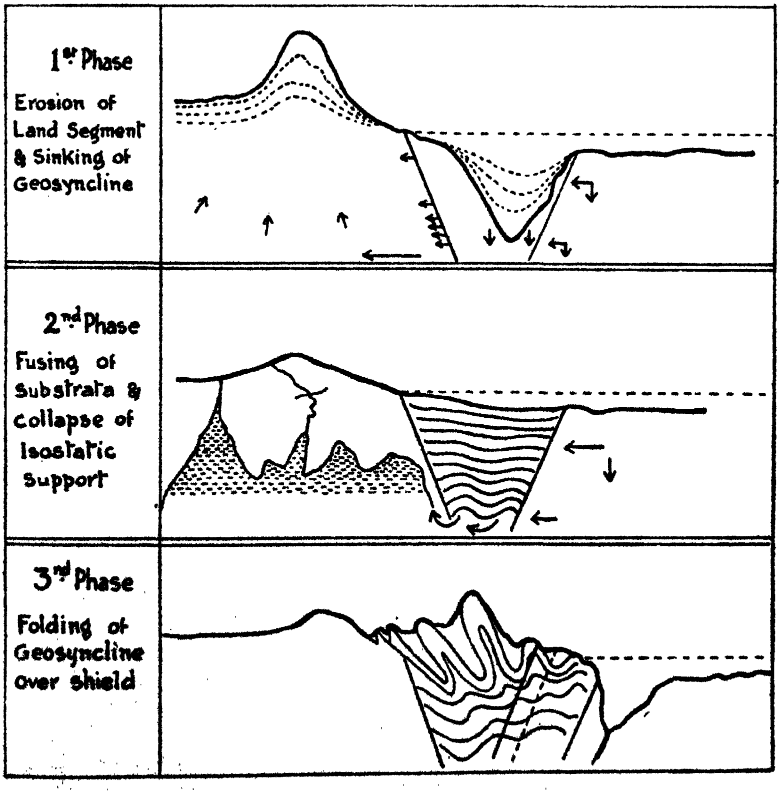
1st Phase
Erosion of Land Segment & Sinking of Geosyncline
2nd Phase
Fusing of Substrata & Collapse of Isostatic Support
3rd Phase
Folding of Geosyncline over shield

Fig. 2.—Diagrammatic Representation of an Epiorogenic Cycle.

However, since the earth is a sphere, any surface area must form a wedge downwards. Therefore any sinking generates pressure on the boundaries of the sinking segment. The land side of the wedge presents the less resistance, as it is less dense than the ocean segment on the opposite side. And here also the sediments are thickest and of a nature less able to resist pressure. As the process continues, the newly deposited sediments are squeezed up and over the margin of the older land mass, and so, in addition to the slow continental uplift, we get a more rapid movement, resulting in the formation of chains of folded mountains along the continental sea-board, with festoons of islands representing a continuation of the process out to sea. (Fig. 3.) All this generates heat from friction, and much of the underlying rock fuses and forms large

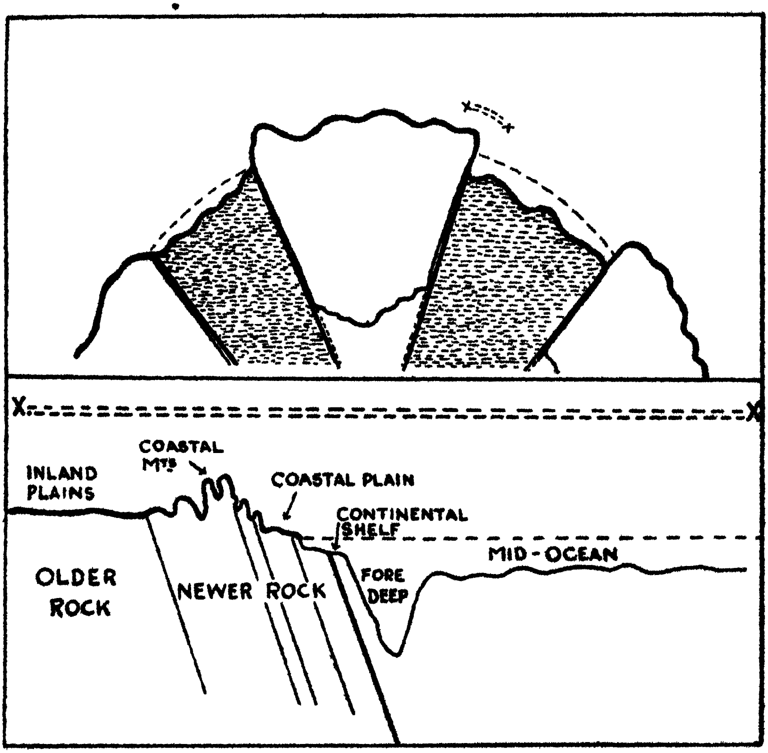

Fig. 3.—Diagrammatic Representation of the Process of Continent-Building.

The upper portion illustrates the effect of the sinking of a segment of the globe. X=======X is enlarged in the lower portion of the diagram, and illustrates the typical margin of the continents.

deep-seated reservoirs of molten rock. This cannot withstand pressure as solid rock can, and the continental mass, in such circumstances, tends to collapse. This happening throws additional stresses on the wedge of newly formed sediments, and completes the process of the formation of great mountain cordilleras like the Alps, Himalayas, Rockies, Andes, &c. (Fig. 3.) It is often accompanied by intense volcanic activity.

The process continues until the pressure is mutually adjusted, and heat is lost by radiation from volcanic extrusions. Weather then commences again to destroy this adjustment. Rock masses are very rigid, and it takes a very considerable difference in stress to overcome this initial resistance. When, however, it is overcome a major world revolution occurs.

RADIO-ACTIVITY

This cycle of adjustment, erosion, uplift, squeeze, collapse, and overfolding of a new zone of rock does not explain everything. There is a further, major pulsation caused by an inherent property of the earth. It is now known that the sun is not getting appreciably cooler. Neither is the earth. This is due to the existence throughout the matter of the sun and its planets of elements possessing what is known as radio-active properties. There are some 30 of these, grouped in two families—*Uranium* and *Thorium*. These minerals are constantly breaking down by the emission of electrically charged atoms of helium and other rays, which are ejected explosively with velocities of thousands of miles a second. You can see the result by examining a luminous watch with a magnifying glass in the dark. If the parent uranium constantly gives off helium, something else must remain. There are, in fact, eight stages, the third of which is radium after three atoms of helium have been discharged. After eight atoms the mineral becomes stable as, chemically, lead *(Ur pb* or *Th pb)*. This change cannot be hastened or retarded. The bombardment produces heat and also chemical change in surrounding rock. You all know the possibilities in this direction of radium.

Two results flow from this attribute of our planet. First, the constant bombardment of surrounding rock generates heat. This is the heat of the earth and of the sun—the difference bearing an exact ratio to the differing proportions of radio-activity in each. The cumulative effect is enormous, particularly as slightly radioactive minerals, such as zircon and orthoclase, are widely distributed, and the simple fact is that the earth is not cooling appreciably. The second result is that an accurate time-scale has been worked out from these minerals. The change is constant. It starts when the rock in which the mineral is found crystallized from a molten magma. The proportion of daughter elements to the parent uranium or thorium can be measured with great accuracy, and the date of the formation of the rock in question can be ascertained almost to a year.

HISTORY

We now know that the sun's heat is not due to combustion—it would not last for 1000 years if such had been the case. We also know that the climate of the earth was much as we now know it, 600 million—perhaps 1600 million—years ago. The fact is that the energy stored in the atoms which make up matter is sufficient for every requirement.

Astronomical data show that the sun has been shining much as it is to-day for 8 billion years, and that the planets separated about 3000 million years ago. The cause of this separation was, most probably, the near approach of a star which raised a tide on the face of the sun, some of which separated and consolidated into nuclei we now call planets. The moon must have separated from the earth at the same time. This date, 3000 million years, accords with astronomical, physical, and radio-active evidence.

Geological history is conventionally divided into certain epochs recognizable as lasting from one major orogenic revolution to the next, and marked by a distinctive grouping of forms of life. In the geological sense, these have been true revolutions—slow to the degree of imperceptible, but when completed, final and terminating a distinct phase of history. Some forms of life have persisted since the earliest times, but in each epoch there has spread over the world a group of more highly specialized forms, which have become extinct at the beginning of the next revolution owing to their inability to adapt themselves to the changed conditions.

Traditionally, geological history commences with the Cambrian period. Radio-active evidence places the middle of this period as 600 million years ago. But we now know that there was a period of 1000 million years prior to that when the world was subject to the same geographical influences as we now know. Therefore we have a period from the earliest times to the time when water was able to condense of some 1400 or 1500 million years, a period equal to the time which has elapsed between that date and the present time. Between the time when water commenced to run and the earliest records of geological history, vaguely termed the Pre-Cambrian, there elapsed a period of 1000 million years, far longer than the whole period about which we know anything. Geology, therefore, can at present only deal with one-fifth of the earth's history, and we must still rely on physics and astronomy for the earlier four-fifths. The principal reason for this is the course of earth movements already mentioned, whereby the older rocks have been worn away long since. The Cambrian dawned with a fully developed and highly organized life, which was probably developing since, or even before, water commenced to flow 1000 million years earlier. By Cambrian times the animal kingdom had developed up to the Crustacea, and the vegetable to highly organized algae. From that date earth history shows a reasonably complete record, although details of geography cannot be confidently traced until we reached the Tertiary period. Some of the more important dates in the earth's history are given in the following table:—

<table>
<tr><td colspan="3">Age of the Sun: 8,000,000,000,000 years</td></tr>
<tr><td colspan="3">Age of the Earth: 3,000,000,000 years</td></tr>
<tr><td colspan="3">Probable Future Life of Earth: 7,500,000,000,000 years</td></tr>
<tr><td colspan="3">Consolidation of Planet—Period of Density—Stratification—Cooling—Crinkling, &c.: 3,000,000,000 to 1,600,000,000 years</td></tr>
<tr><td colspan="3">Commencement of Erosion and Deposition of Earliest Sedimentary Rocks: 1,600,000,000 years</td></tr>
<tr><td colspan="3">Age of Oldest Rocks now remaining—Geological History begins: 640,000,000 years</td></tr>
<tr><td>CAMBRIAN</td><td>600,000,000</td><td>Life well developed</td></tr>
<tr><td>DEVONIAN</td><td>390,000,000</td><td>Vertebrate animals and land plants first appeared</td></tr>
<tr><td>PERMIAN</td><td>220,000,000</td><td>Existing plant phyla and animal phyla up to Reptiles are represented</td></tr>
<tr><td>CRETACEOUS</td><td>100,000,000</td><td>Mammals well established</td></tr>
<tr><td>TERTIARY</td><td>100,000,000 to 1,000,000</td><td>Primates first appeared</td></tr>
<tr><td>PLEISTOCENE</td><td>1,000,000 to present day</td><td>Man first appeared</td></tr>
<tr><td><i>Pre-Glacial</i>
<i>Günz</i>
<i>Riss-Würm</i>
<i>Würm</i></td><td>1,000,000
800,000
250,000
100,000
40,000</td><td>Pithecanthropus
Negrito
Neolithic
Aryan
Bronze Age (Azilian)</td></tr>
</table>

The succession of events as disclosed by this history is as follows: After a very long period, marked by a fairly uniform grouping of forms of life, erosion produces a flat, level world, with deep accumulations of sediments in long troughs off the edge of the continents. The general temperature gradually rises under the influence of radio-active properties in the earth's crust,, and this is accompanied by a degree of fusion of the substrata allowing the surface to adjust with great delicacy. Coal measures, often thousands of feet thick, show an adjustment to water-level so perfect that the addition of one-eighth of an inch of sand depresses the level by a corresponding amount. This phase is accompanied by a very equitable climate, and becomes a *coal age*. In time, the pressure of accumulating sediments squeezes out molten rock to the surface, and we have a major *volcanic period*, such as covered the Deccan 600,000 square miles with lava 1000 feet thick, and Southern Australia from Mount Gambier in South Australia to Melbourne and North-East Tasmania with basaltic lava in places hundreds of feet in thickness. This is accompanied by a period of great mountain foldings. These two results release the accumulated pressures and internal heat, and are followed by an *ice age*. Then the world settles down to a long period of quiescence—30 million years or so—until erosion again upsets the balance. The forms of life develop slowly during the quiescent period, primarily under the influence of normal biological controls, but each revolution marks a change in environment, which is always accompanied by the extermination of many forms, the rise of some newer and more highly developed forms, and a regrouping of life generally. The ancestral forms of each phylum have probably been in existence since Pre-Cambrian times, but each revolution gives an impetus to some previously repressed form, and spurs on development to an extent not seen with any other influence.

There have been, in all, some 20 revolutions of varying intensity, of which some four or six were of outstanding intensity. These are usually known as: (1) The Charian, which initiated the Cambrian period; (2) the Caledonian, which terminated the Silurian and initiated the Devonian; (3) the Hercynian, which terminated the Permian period—the end of the Palaeozoic era—and initiated the Mesozoic era; and (4) the Alpine, which commenced in the early Tertiary, and which is only just terminating. It is impossible here to describe the effects of these revolutions, and I must be content to remark that each produced very definite land masses and mountain ranges, traced in many parts of the world, and which were reflected in Tasmania.

We may therefore truly describe the world as pulsating. History shows a definite rhythm, and this rhythm is part of the very nature of the earth. Moreover, it has supplied the motif for the development of all land features and all forms of plant and animal life. Indeed, it is not too much to say that life itself is but one manifestation of this pulsating, rhythmic attribute of the earth—the mother of all life.

MAN

And so, finally, we come to MAN. It is out of the question for me to discuss here the origin of the genus of *Homo*, but we can see the results of the world's pulsations nowhere better than in the story of the human race. When the early ancestors of the primates were hunting across the Eurasian plains with their shaggy coats and long tails, there were no Alps or Himalayas, no Mediterranean, no Bass Strait. The Tertiary period has witnessed the development of our present geography. The preceding era had been the age of the giant reptiles. With the beginnings of the Tertiary we see the rise to prominence of the insects and their associates—the flowering plants and grasses. At first, plant and animal forms spread indiscriminately through the world—eucalyptus trees and marsupials in Europe and America, oaks, elms, willows, &c., in Australia. At this time land was emerging from the great sea, Thetys. Ancient Malaya connected Southern India with Australia, Central Australia and the Ganges valley were under the ocean, and Tasmania was connected to South America *via* the Antarctic. Then followed a great outpouring of volcanic lava over a considerable portion of the earth's surface. The Alpine-Himalayan chain was gradually folded over the remnants of the Hercynian mountains, and the Pacific squeezed its margins outwards over America, Asia, and Australia. Finally, the world passed into the last ice age—from which we are now only just emerging.

The world is divided into certain geographical zones, as shown in Fig. 4. Man originated in the equatorial forest belt (from North Africa to Malaya), before the Alpine-Himalayan chain had been raised sufficiently to form an impassable barrier, and here the forbears of our race lived for perhaps 10 million years, until the pulsations of the globe which gave them birth shook them from their leisured existence. The gradually rising mountain barriers very early segregated branches of the human family, and, probably, from originally black-skinned ancestors the more progressive races developed from stocks trapped north of the mountains. Then the ice age came on. This had a very marked bearing on the distribution of these geographical zones. Segregation into such zones does not appear to be usual in earth history, but is a definite accompaniment of an ice age, and the polar ice sheets control the distribution of each zone. As the ice advances from the poles each zone presses nearer the equator and contracts the equatorial forest belt, and as the ice retreats the other zones follow it towards the poles, allowing the equatorial forest belt to expand. There were four separate ice invasions during the last ice age. Four times the ice has advanced and receded. On each occasion it reached to about the latitude of southern England, central Germany, and Russia, and the Canadian-U.S.A. border.

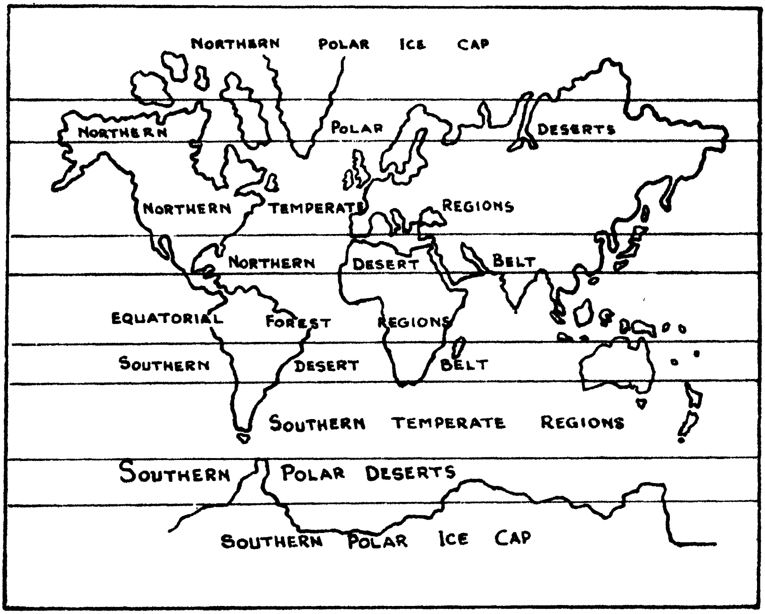

Fig. 4.—The Major Geographical Zones of the Surface of the World.

Prior to the first onset, man's ancestors had spread widely through the tropical forests. It took a large area to support a small number of these primitive tribes. Apes and monkeys were well developed, and also *Pithecantropus* and his contemporaries. Then the ice came down and pushed the desert belt southward, contracting the forests, and, with them, man's food areas. In time, the ice receded, but the consequence of the intense struggle for existence caused by this restriction was a new race of mankind—higher in every way. This happened three times more, until the modern races grew from the intense struggles of nature's testing—aided in some cases by climate and by the fact that some races were trapped between mountains and deserts to the south and the cold temperature regions to the north. These influences also directed and controlled migrations until the greater portion of the world was populated. In places, earth movements and long extensions of the oceans along newly forming troughs cut off and protected remnants of earlier races. In other parts the struggle for existence, nature's uplifting influence, continued, for some fortunate groups, the work initiated by ice.

Another and very important factor also resulted from the ice age. As a great deal of water was stored up as ice, the level of the sea sank. This occurred to a depth of 150 feet all over the world at the time of maximum intensity. During that time rivers and streams were enabled to cut below present sea-level, and coral reefs could grow at a depth at which coral cannot live to-day. As the ice melted the sea level arose and dammed back the newly cut valleys. During the interglacial phases the sea level actually rose higher than we see it to-day, as we are not yet entirely out of the last, or fourth, glacial phase. This caused the streams to deposit terraces in their newly eroded valleys. During later ice phases these terraces were largely eroded again. So we can see to-day over much of the world, including Tasmania, a definite series of three or four terraces at the mouths of rivers. Now, primitive races of mankind lived along the courses of these rivers, and left their bones and their tools in the river mud and gravel. The anatomist can trace the development of the races in the bone remains, and the association of stone implements with these bones enables us to classify human culture in historical sequence. The geographical sequence of the terraces is easy to work out, and in this way human history has been correlated with the earth pulsations which both produced the terraces and induced the development of successive races. To this scale has been added another. In regions on the border of an ice cap, in winter time, the water is frozen and stationary. Summer melts much ice, and the water carries away a great quantity of material worn by the ice from its bed. This is deposited as a fairly thick layer. The succeeding winter makes a break, when only a very thin layer or none at all is deposited. Thus is built up a rock known as *varved shales*, in which the record of passing years is accurately preserved. These alternating seasonal layers have been counted in many places, and an absolutely correct time scale is thus provided.

The story of the human race has been laboriously built up from all those various factors, and we can now place the origin of different peoples in their correct relationship relatively to each other. We can connect human occupation of a given locality with the river terrace in the process of formation at the time of that occupation, and we can correlate these terraces by means of the known phases of the ice invasions, with corresponding terraces anywhere in the world. The combined result gives us an accurate history of man's occupancy of the earth and an accurate geography of any given locality at any particular stage of the human period. (See for Tasmania the diagrams given in my paper published in this journal for 1934. The succession there given corresponds very closely with that in England.)

EARTH MOVEMENTS IN TASMANIA

Tasmania occupies a very important and definite position in geography as a wedge of the Australian continental mass projecting into the oceanic masses to the east and west. These masses have been in approximately the same relative position since the beginning of geological time, and Tasmania has been, as it were, a buffer. Thus, it has been subjected to continued stresses—at one time of compression, at another of torsion—with a result that it has never been stable, and, whereas on the mainland it is possible to go from Broken Hill to Broome—nearly 3000 miles—without a major change of rock, Tasmania has representatives of almost every geological period and has felt the effects of every earth movement. (Fig. 5.)

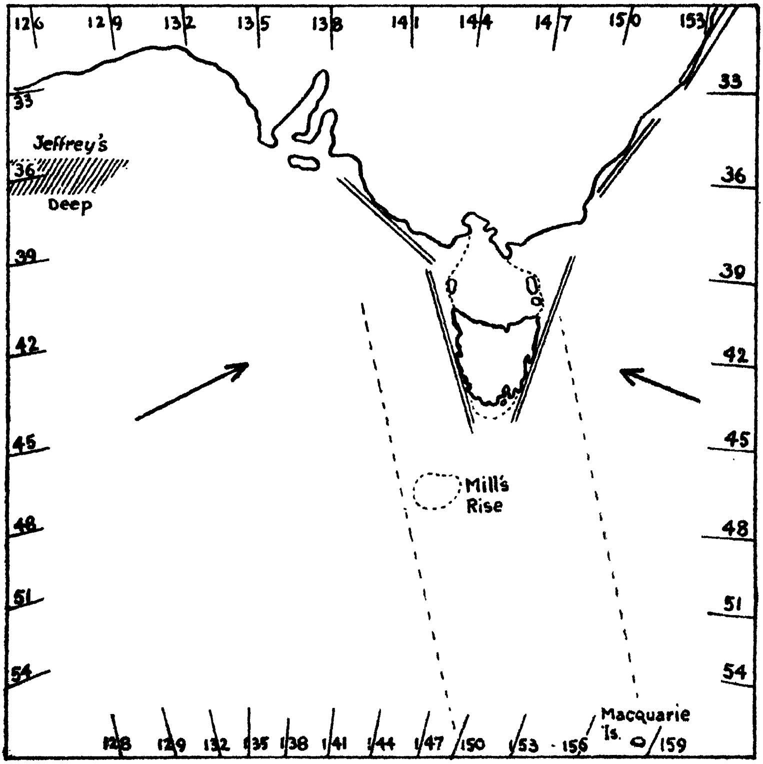

Fig. 5.—The Major Continental Trend Lines in the Neighbourhood of the Tasmanian Peninsula.

Tasmania is the southern terminal of the Eastern Australian Continent. Bass Strait is merely a flooded portion of this peninsula. The diagram illustrates the position of Tasmania as a wedge between two converging pressures. The submarine ridge of which Mill's Rise and Macquarie Island are portions has not yet been satisfactorily explained, but is clearly associated with the general structure of the Eastern Australian Continent.

We have only time to deal with the most recent. A revolution which closed the Silurian, and which may be roughly correlated with the Caledonian of Europe, left a cordillera of mountains over the present position of Tasmania, folded over older land to the west and enclosing great batholiths of granite. This would be some 420 million years ago. Before Carboniferous times these mountains had been eroded to a plain, exposing the granite cores. One hundred and sixty million years are represented in this phase. Then followed a general and very slow subsidence to the southward about an axis roughly across Northern Tasmania. (Fig. 6.) In

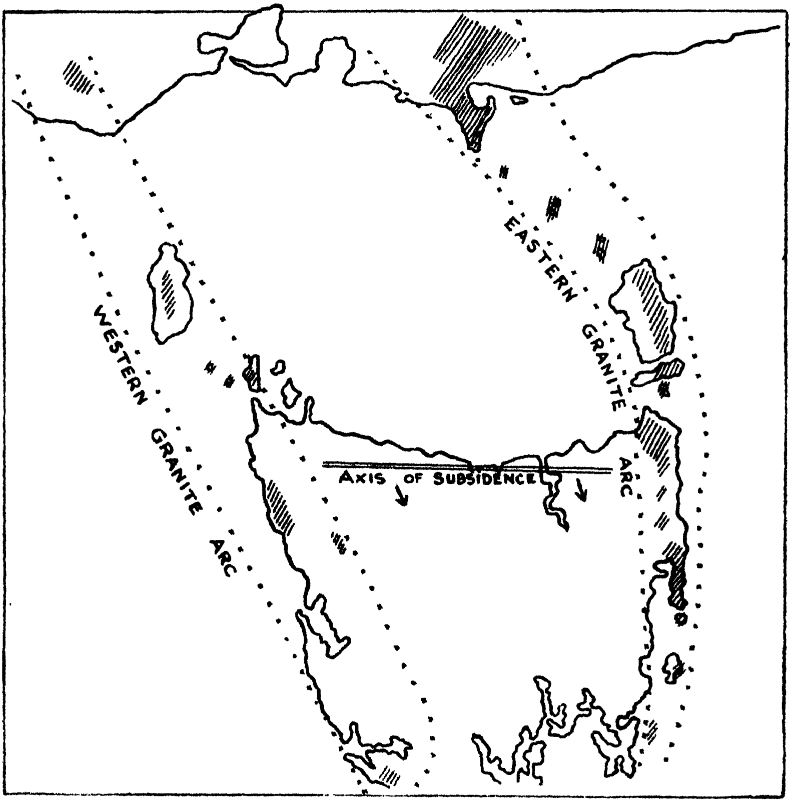

Fig. 6.—The Two Granite Arcs.

These form the skeleton of Tasmanian physiographic structure. The actual centre of the axis of subsidence during Permian times may have been further north, under the now flooded Bass Strait, but the position shown on the diagram is the apparent axis as far as data at present available indicate. Granite outcrops are shaded. Many facts indicate considerable subterranean masses within the dotted lines indicating each arc.

the trough thus formed, which was probably only the northern extension of a greater block extending perhaps to Antarctica, sediments typical of shallow seas, sand dunes, and swamps, accumulated to a depth of perhaps 8000 feet. This phase extended until the Triassic or Jurassic periods, some 60 million years. Then the geosyncline thus formed foundered in an upwelling magma of basaltic *Sima*, which intruded on the sediments, and gave us our dolerite rocks. These sequences are also to be found on the coast of Antarctica opposite Tasmania, indicating that Tasmania and Adelie Land were the edges of a vast foundering land mass. The doleritic intrusions may be roughly correlated with the Hercynian revolution of Europe, but somewhat later in point of time.

We can form little idea of the geography of Tasmania at this time, but it was very broken, with perhaps mountain ranges. A long interval of quiescence followed—some 100 million years—during which the land was worn to a level plain. Then Tasmania felt the effects of the earth revolution which also produced the Alpine-Himalayan and Rocky-Andean mountain chains. At this time, and very likely at other earlier times, Tasmania extended far to the east and west of its present coasts, and was part of an inland continental mass. The Alpine revolution was not felt as severely as in Europe or New Zealand, but more so than in Australia. As a result of pressure from east and west, Tasmania was broken and uplifted in jagged blocks, and at the same time there were large subsidences off the coasts. The first of the uplifts raised the western area and the north-east corner, and sufficient time elapsed to erode the overlying sediments and dolerite sills from these parts. This uplift must have been in the vicinity of 8000 feet, and was most pronounced. Then came a fairly general uplift over all Southern and Eastern Tasmania, excluding the north coast and the midlands. The extent of this was about 1500 feet. Subsequently disjointed blocks were raised to a further 3000 feet, and now appear as our mountains. There were several such movements, and blocks were raised differentially. Accompanying these uplifts, considerable subsidence off the west and the north-east coasts occurred, and, later, a large area off the southern coast of Tasmania, including Storm Bay, foundered along very regular breaks. This, in its turn, had a marked effect on the valley erosion in the south, rejuvenating the rivers and giving a marked trough in the old valleys. The original sides of the pre-submergence valleys can be plainly seen on the platform at 500-400 feet along the Derwent Valley and hills of Southern Tasmania.

These movements extended into the ice age. We can follow the four ice ages in Tasmania, although the first is obscure. These provide an excellent correlating time-scale, particularly as the latest elevation occurred subsequently to the two earlier ice phases. It is apparent that very dry conditions prevailed in Tasmania during some of the interglacial phases, and during the ice phases many rivers in the unaffected coastal portions were much more considerable than at the present time. River terraces all along our coasts correspond very closely with similar features in Europe.

During each ice age the streams cut below present sea-level, and during each interglacial phase the sea-level rose and banked back the streams so that they deposited terraces in the valleys previously excavated. These terraces can be correlated with the various ice ages. So can the movements of the desert belts. Therefore, when the remains left by a particular human race are found in or on a particular terrace you can say that they appeared in that locality at a given time. These successive factors have been worked out for the Thames valley, and now research shows that a corresponding time-scale is available for Tasmania. The Derwent, Coal, Huon, and Tamar valleys show series of terraces that correspond remarkably accurately with those of Europe. The Derwent and other rivers have cut 150 feet below present sea level, and have piled up terraces to an elevation of 100 feet above sea level (Lewis, 1935). These over-deepenings and terraces correspond to the rise and fall of the sea level during the ice age. During these rises and fallings, so accurately marked by river cuttings and terrace buildings, and, in higher altitudes, by the effect of ice, man arrived in Tasmania. The date can be accurately fixed as during the Yolande-Margaret interglacial, as his artifacts appear suddenly on these terraces. That corresponds to the Riss-Würm, interglacial of the northern hemisphere, and may be dated as 150,000 years ago.

A considerable controversy has arisen lately as to how the Tasmanian aborigines arrived here. Until the last year or so, Sir Edgeworth David's dictum that they arrived across a dry Bassian land bridge was accepted. Professor David showed that the maximum phase of the Mindel (Malanna) glaciation the sea was 150 feet lower than it is to-day. That this was so is demonstrated by the Derwent trough. This would have been sufficient to have given a double land bridge across Bass Strait. Unfortunately for this convenient theory, recent work shows that the aborigines did not arrive until much later. During Mindel times—some 600,000 years ago—the Negrito race, of which the Tasmanians were a branch, were developing in Northern India, and had not spread further. They did not reach Southern Australia until much later. The subsequent ice ages were not sufficiently intense to lower the sea level to a depth which would make a land connexion between Tasmania and Victoria. Investigation of the coast of Bass Strait indicates that the coast-line, at any rate, has not sunk in post-Yolande times.

Why did the aborigines cross to Tasmania? The answer is clear. Throughout the period from their first migration into Australia, the central desert belt, in response to the pull of the ice-sheet, was moving up and down across the continent. At the time they first appeared in Tasmania the southern portion of Australia was in the grip of the desert. To such an extent was this so that the Buffalo ranges in Victoria at 5000 feet show no signs of permanent snow, while ice descended to sea level on the west coast of Tasmania only 400 miles further south.

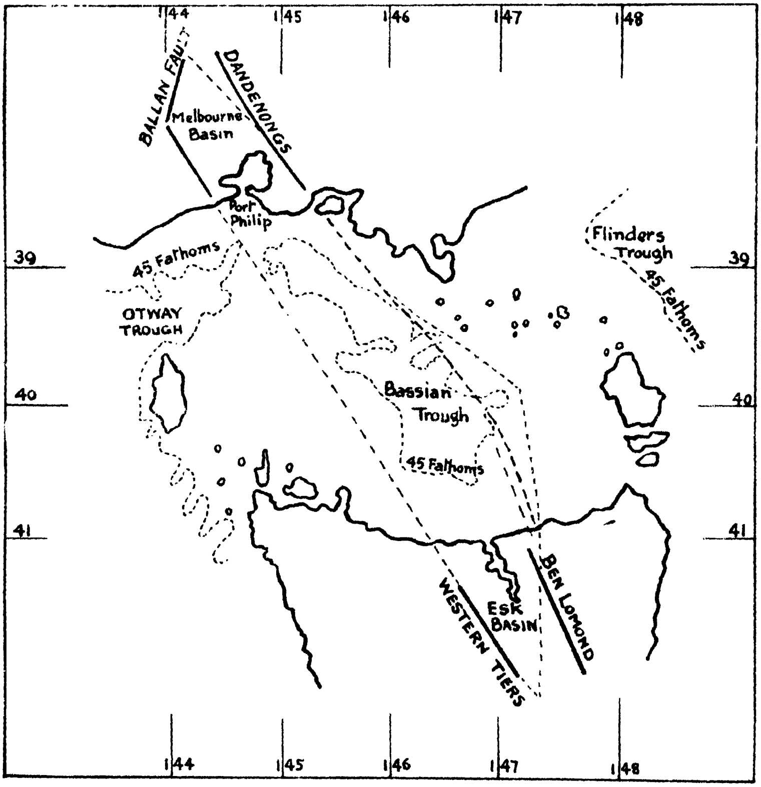

Fig. 7.—The Bassian Trough.

The diagram illustrates the general trend lines of the geography of Bass Strait. It also illustrates the vital connexion between geographical data to be gathered on both sides of the strait. The neglect of this correlation has led to many of the doubts which now exist as to the geography of South-eastern Australia.

An examination of Bass Strait is instructive. Although the Tasmanian coast shows terraces dating back to at least Yolande times, soundings disclose a peculiar trough 270 feet below sea level. This is a lenticular extension of the plains that run from Tunbridge to the coast in Tasmania, and from Bacchus Marsh to Port

Phillip in Victoria, and it connects these plains. The Bassian trough cannot be waterworn, and as there is no outlet, if it had not been flooded, it would have been an inland sea or salt lake. It can only be due to earth movements. The subsidence south of Tasmania is of very recent date, so much so that at least two river valleys flowing from the ocean northwards are observable—one at Port Davey and one at Cockle Creek. The Flinders and Otway troughs and the subsidence to the south indicate a squeezing movement, and point to the origin of this submerged inland sea. When did all this happen? The very shape and nature of the Bassian trough point to a possible counterpart—the Dead Sea and Jordan Valley.

PALESTINE AS A KEY TO TASMANIAN PHYSIOGRAPHY

Palestine presents a remarkable key to some of the problems of more recent Tasmanian physiography. The plateaux of Judea and Moab were uplifted at approximately the same time as our Central Plateau, and to the same height. The earth movements that produced both sets of features were due to the same agency, and were exactly similar in origin and effect, and the boundary fractures as described for Palestine might be the faults which are causing us so many difficulties in interpretation here. Pictures of the Judean Mountains from the Philistine Plain, and of the Western Tiers from the South Esk Valley, illustrate the similarity better than any words can do. But beyond these features, there are two others: (1) The flooded area of the Mediterranean, and (2) the rift valley of Dead Sea. From Galilee to Akaba there extends a break in the plateau which, at one place, drops to 600 feet below the sea level. This is an area which has played the most important part in the history of mankind, and there has been preserved for us an actual historical record of happenings here during the life of human beings. We now have brought our story of the world down to the time of the Book of Genesis. Two early legends are there preserved from a time far more ancient than the time when they were reduced to writing. The first is the story of the Flood, and the second is the story of Lot.

The Flood was an actual happening, established beyond doubt by the wide distribution of legends through the earliest writings of mankind. It was presumed, until recently, that it was the result of the rising of the sea level after the last (Würm or Margaret) ice phase. It could not have been this, as the rise was insignificant. The rise after the Mindel ice sheet had waned would have been sufficient, but at that time—600,000 years ago—the human race was too primitive to make records. The evidence all points to the fact that the Flood was the result of the submergence of the Mediterranean-Euxine-Caspian-Aral basin, as the last phase of the earth movements associated with the Alpine revolution. The land then submerged was the happy hunting ground of the Iberian peoples, sometimes known as the Dark Whites, represented in history by the Iberians of Spain, the Trojans, the Philistines with their great cities Tyre and Carthage, the Helots of Greece, and some of the tribes of Italy. These people were 'wicked' (that is, foreigners) to the writers of the Old Testament. To them the Flood was the outstanding event in history and the source of many legends. At about the same time, and as the result of similar earth movements, the transverse fissure of the Jordan valley subsided and we read the account, written at a much later date, of this happening in the story of Lot. The Cities of the Plain are traditionallly situated in the Dead Sea basin, and Genesis specifically mentions Lot as escaping to Moab, an unlikely course if these cities had been situate in the Philistine Plain. No other localities fit. Genesis states that Sodom and Gomorrah were overwhelmed with fire and brimstone. No volcanic activity appears to have occurred in these regions, but earthquake movements were highly probable, and considerable landslides from the 4000-foot cliffs surrounding the rift valley were also possible. The date of these happenings may be fixed at late Azilian times—about 40,000 B.C.—and they are confirmed by ethnological, geological, and geographical evidence.

Some such minor earth adjustment is apparent across Bass Strait and to the south of Tasmania, and the similarity is too close to be ignored, although, getting so close to the present day, actual contemporaneity to a few thousand years cannot be pressed in the present state of our knowledge. Nevertheless this fact is undoubted. We see certain results of earth movements in Tasmania, and portion of the human race has left some legendary records of very similar happenings elsewhere. In the absence of reasonable text-books of Tasmanian geography we must turn to the legends of Genesis for assistance.

In the present imperfect state of our knowledge I am not prepared to say that Bass Strait was submerged after the coming of the Tasmanian aborigines. The evidence of the coastal terraces points in the other direction, but Bass Strait is an earthquake zone at the present time, and the great trough was probably the result of a continual pressure or subsidence after the formation of the terraces and the passage of the aborigines. This, however, does not affect the general similarity of the earth movements.

I give below a list of works which should be consulted by students who are interested in the subject of this lecture. The list is arranged in the order recommended for study.

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PAP. & PROC. ROY. SOC. TASMANIA, 1935 (17TH AUGUST, 1936).

The Trout-Food Insects of Tasmania

Part II.—A Monograph of the Mayflies of Tasmania

By

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PLATE I

In Part I of this series of studies, (1934) I dealt with the problem of the genotype of the Mayfly genus *Atalophlebia* Eaton. Now that this problem is satisfactorily solved, and the characters of the genus firmly established, it is possible to make a survey of the whole Mayfly fauna of Tasmania. The interesting fact at once emerges that about two-thirds of this fauna consist of species of *Atalophlebia*, and that most of the species have a very close relationship with forms which occur on the highlands of Victoria and southern New South Wales. But in these parts of continental Australia the Mayfly fauna is far more varied than it is in Tasmania. In the family Siphlonuridae, there is only a single species of *Tasmanophlebia* recorded from Tasmania, whereas from the Mount Kosciusko region alone (Tillyard, 1933) there are known, in this family, two species of *Tasmanophlebia*, one of *Ameletoides*, and two of *Coloburiscus*.

Of these, it is noteworthy that *Tasmanophlebia* possesses nymphs which live in still, or nearly still, water, whereas those of the other two genera require running water. In the family Leptophlebiidae again, the most striking development of species in Tasmania is a group of closely-related species of large size in which the structure of the gills appears to indicate that they have all been originally derived from one or two forms whose nymphs inhabited still or slowly-running water. In the Mount Kosciusko region, on the other hand, the principal development of this same genus consists of a complex of forms whose nymphs live in fast-running water, and there is also present a related genus, as yet undescribed, whose larva burrows into the sandy beds of running streams.

Thus, in studying the Mayfly fauna of Tasmania, we are faced at once with the same problem as in the case of the Dragonflies: although the island is plentifully supplied with fast-running rivers, the aquatic fauna present appears to have been derived from a stock living in still or slowly-moving water. As I have pointed out previously, in my study of the Dragonflies in relation to the Bassian Isthmus [i.e., the original land-connexion between Tasmania and the mainland (Tillyard, 1914)], no less than 78·9 per cent. of the still-water species of Odonata are common to Tasmania and Victoria out of the species found in both States; whereas, in the case of the running-water forms, only 22·7 per cent. are common to both, and, of these, one is a species which occasionally breeds in still water, and the other two breed in slowly-running water.

The inevitable conclusion must be that, during the geological periods in which most of the Tasmanian Dragonfly and Mayfly fauna reached the island, the land-connexion with Australia proper was only a narrow, or possibly even a discontinuous, one, with sufficient still waters to allow of the free migration of forms inhabiting them, but with so little development of permanently-running streams that very few of the forms inhabiting such streams were able to get across. Further, it is clear that the great majority of species reached Tasmania from the north, and not from the south, though there is one important exception, viz., the rare Dragonfly *Archipetalia auriculata* Till. from the Cradle Mountain region, which had not been discovered when my 1914 paper was written.

Although, no doubt, further collecting, particularly in the western half of Tasmania, will bring to light a few more species, we know enough about the Tasmanian Mayflies to be able to give a fairly full account of them. It appears, for instance, highly improbable that the Siphlonurid genus *Coloburiscus* occurs at all on the island, although it is common in all fast-running streams throughout New Zealand and on the highlands of Eastern Australia. This genus is taken as the 'indicator' for good trout-streams in New Zealand; for wherever its larva occurs, the water is found to be of first-class quality for trout and of exceptional purity. It is certain that, if any species of this genus had succeeded in getting into Tasmania, it would have spread rapidly through all the fast-running rivers, and would have made an excellent food for trout. But so far it has not been found, though the larvae are conspicuous objects of comparatively large size.

In the present paper the following Mayfly fauna is dealt with:—

Family SIPHLONURIDAE	1. *Tasmanophlebia lacustris* Till.
Family LEPTOPHLEBIIDAE ...	2. *Atalophlebia australis* (Walk.)
	3. *Atalophlebia superba*, sp. nov.
	4. *Atalophlebia hudsoni*, sp. nov.
	5. *Atalophlebia albiterminata*, sp.
	6. *Atalophlebia ida*, sp. nov.
	7. *Atalophlebia fuscula*, sp. nov.
	8. *Atalophlebia brunnea*, sp. nov.
	9. *Atalophlebia delicatula*, sp. nov.
Family BAËTIDAE	10. *Baëtis frater*, sp. nov.
	11. *Cloëon tasmaniae*, sp. nov.
Family CAENIDAE	12. *Tasmanocoenis tonnoiri* Lestage
	13. *Caenis scotti*, sp. nov.

KEY TO FAMILIES

1. Hindwings comparatively large, about half as long as the fore	Fam. *Siphlonuridae*
Hindwings small or entirely absent	2
2. Forewings with a plentiful supply of cross-veins, giving a reticulate appearance; hindwings small, but also reticulated	Fam. *Leptophlebiidae*
Forewings with few cross-veins and a generally open appearance	3
3. Males with turban-eyes (Text-figs. 24, 25); marginal short veins (intercalary veins) developed between the ends of the main veins	Fam. *Baëtidae*
Males with small, button-like eyes placed wide apart; no marginal short veins developed between the ends of the main veins	Fam. *Caenidae*

In defining the families and genera more fully, recourse must be had to the venational scheme, where the main differences relied upon for classification are to be found. Reference should therefore be made to the text-figures of the wings of the various genera, in which the Comstock-Needham terminology is used, as amended by myself for this particular order. Students should note, in particular, that there is, in the Mayfly wing, a complete alternation of convex and concave veins; this is indicated in the legend of text-fig. 1. It is usual to indicate convex veins by the sign +, and concave veins by the sign —.

To Lameere is due the recognition that the media in Mayfly wings is a composite vein, consisting of *anterior (convex) media*, MA, and *posterior (concave) media*, MP. In all existing Mayflies, MA is attached basally to the radial sector, Rs. In order to bring the notation of the cubitus as far as possible into line with that of the media, the *anterior (convex) cubitus* is here designated CuA, instead of the usual Cu_1, and the posterior (concave) cubitus CuP, instead of the usual Cu_2. This course also enables us to avoid awkward suffixes for the branches of CuA. It should also be noted that the main stem of the radius is really the anterior convex portion of that vein, and might with advantage be termed RA, while the 'radial sector,' universally known as Rs, is in reality the posterior concave portion, and might be more logically termed RP.

Mayfly venation (text-fig. 1) differs essentially from that of any other order of insects, not only in the complete alternation of convex and concave veins, but also in the formation of *triads*. When a main vein branches distally into two, the alternation of convex and concave veins is kept intact by the development, between these two branches, of an extra, interpolated vein of opposite sign between the two branches. These middle veins of triads are distinguished by the addition of the prefix 'I'; e.g., the triad of MA consists of MA_1 (+) IMA (−), and MA_2 (+). Triads are normally developed on the branches of Rs, Ma, and MP only, i.e., on those branches which proceed to the distal or outer margin of the wing, from apex to tornus. As it is doubtful how far the formation of the distal part of CuA in the Leptophlebiidae is a true triad, it is left unlabelled in this paper. In the older family Siphlonuridae there is no triad on CuA, but a pectinate series of descending veinlets. A short interpolated anal vein, IA, can also be recognized in this family.

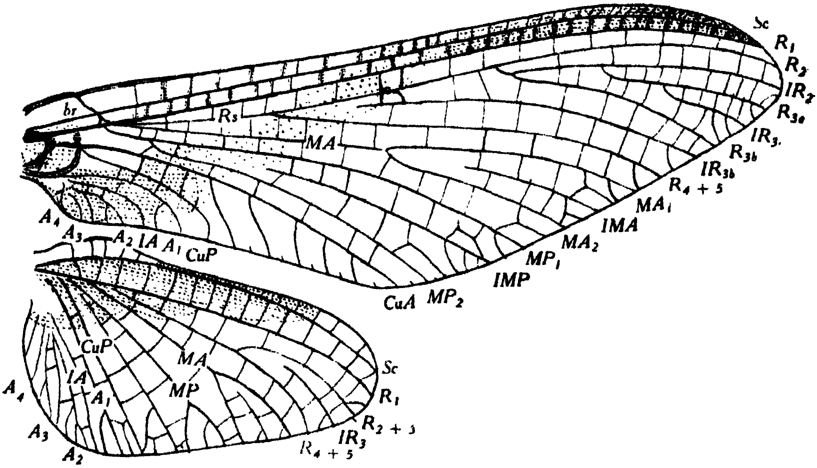


Fig. 1.—Venation of *Tasmanophlebia lacustris* Till. Male imago, from Great Lake, Tasmania.

A_1, A_2, A_3, anal veins (convex); *br* bridge vein; C, costa (convex); CuA, anterior cubitus (convex); CuP, posterior cubitus (concave); MA, anterior media (convex); MP, posterior media (concave); *pt*, pterostigma: R_1, radius (convex); R_2, R_3, R_4, R_5, branches of the radial sector, Rs, all concave; Sc, subcosta (concave); interpolated veins (middle members of triads) are distinguished by the prefix "I."

Family SIPHLONURIDAE

Genus **Tasmanophlebia** Tillyard. 1921

This genus, the only known Tasmanian representative of the family, can be at once recognized by the large size of the hindwings, which are about half as long as the fore and almost as wide, with the humeral angle well developed and obtuse. In the forewing the triad of MA is distally placed, that of MP very long, arising basally, and not attached to CuA. In correlation with the size of the hindwing, the tornus or posterior angle of the forewing is placed about half-way between base and apex, giving the wing the general shape of an obtuse-angled triangle.

In both sexes, except in the forelegs of the male, the tarsi are apparently only four-segmented, owing to the basal segment being more or less fused with the tibia; the forelegs of the male are greatly elongated. The tarsal claws are in all cases dissimilar, one being sharply hooked and one broad and blunt, with rounded apex. The abdomen is narrowly cylindrical, without any lateral dilations.

The *larva* or *nymph* is free-swimming, dorso-ventrally flattened, the thorax not humped; the abdominal segments have a median dorsal crest and lateral flanges with strongly projecting posterior angles. There are only four pairs of simple gills, carried dorsally upon the abdomen, one pair on each of segments 1-4; of these, the first pair are strongly chitinized lamellae forming gill-covers or opercula for the rest, which fit closely under them.

The genus is the Australian and Tasmanian representative of the well-known New Zealand genus *Oniscigaster* McLach. It differs from the latter in not possessing lateral flanges to any of the abdominal segments in the adult, and in the specialization and reduction of the nymphal gills.

Genotype.—Tasmanophlebia lacustris Till.

Habitat.—Lakes and still reaches of mountain streams in Tasmania and the uplands of South-Eastern Australia.

1. Tasmanophlebia lacustris Till.

(Plate I, figs. 1, 2; text-figs. 1, 2, 3)

Tillyard, 1921, *Proc. Linn. Soc. N.S.W.*, xlvi., pp. 409-412, pl. xxxiv.

This species was originally described from Lake Lilla, Cradle Mountain, North-Western Tasmania. It is now known to occur also in the Great Lake, Lakes Echo and St. Clair, and more commonly in the Penstock and Shannon Lagoons, not far from the Great Lake.

The type series, consisting of one imago of each sex and also one subimago of each sex, is now seen to be somewhat below the average size of the species; the average expanse is about an inch, the males being slightly smaller than the females, and much less numerous. Some additions to the original description may suitably be made here, as follows:—

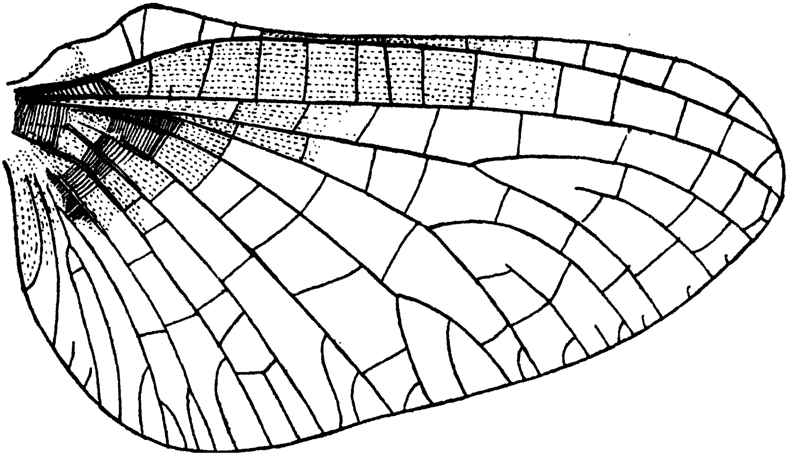


Fig. 2.—*Tasmanophlebia lacustris* Till. Hindwing. Length 5·5 mm.

In the IMAGO, the male can be at once distinguished from the female by a rich brown longitudinal mark on the forewing (Plate I, figs. 1, 2), extending outwards from the base posteriorly to CuP. There is a similar but longer mark, about 3 mm. long, covering the basal sixth of the hindwing and also extending outwards along the subcostal space to about two-thirds (text-fig. 2). Further, the brown markings along the costa of the forewing are much stronger in the male, particularly in the region of the pterostigma.

The *hindwing* (text-fig. 2) differs from those of the mainland species in having the humeral projection of the costal margin irregular and rounded at its apex instead of being a simple obtuse angle. The definition of the genus therefore needs to be amended, and should properly read 'hindwing with humeral angle prominent, either obtuse-angled or irregularly humped and rounded.'

In the SUBIMAGO, the general colour of the wings in both sexes is a medium fuscous, with a slightly paler lunule passing from about the middle of the costa of the forewing to the tornus; the part of the wing situated basally from the lunule is slightly paler than the distal part; in the hindwing, the wing is darkest around the distal portion.

The NYMPH (text-fig. 3), previously unknown, may be described as follows:—Total length of body (average) 16 mm., tail filaments 6 mm. *Head* narrow, eyes wide apart in female but touching in male; antennae short, subulicorn. Thorax fairly stout; the legs short, rather slender, tibio-tarsus divided obliquely and ending in a single claw. *Abdomen* with short, backwardly projecting dorsal spines only on segs. 1-5; lateral spines present on segs. 1-9. Gill-covers or opercula large, extending to the end of seg. 5, slightly irregular in shape, the inner margin subangulate not far from base, but otherwise oval in form. Caudal filaments short, strongly fringed, the middle one on both sides, the outer ones on the inner margin only. General coloration sandy, with mottled brownish markings; eyes and wing-sheaths dark, tail filaments with darker annulations.

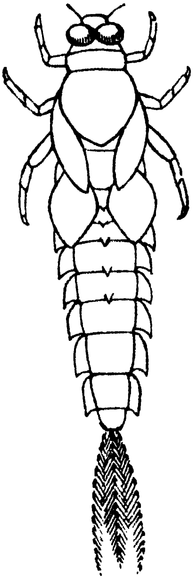


Fig. 3.—*Tasmanophlebia lacustris* Till. Full-grown nymph (male). Length, excluding tail-filaments, 16 mm.

In general appearance, this nymph comes close to that of *T. nigrescens* Till. from Mount Kosciusko (Tillyard, 1934, p. 19); it also agrees with it in having the dorsal spines confined to segs. 1-5; these, however, are much smaller and less nodding than in *T. nigrescens*, that of seg. 1 particularly being small.

Types.—Holotype male imago, allotype female imago, type male and female subimagos, from Lake Lilla, Cradle Mountain, North-Western Tasmania (R. J. Tillyard, 21st January, 1917); type nymph (male) and series of paratypes (in spirit), from Todd's Corner, Great Lake (R. J. Tillyard, 28th January, 1933).

Family LEPTOPHLEBIIDAE

In this family the hindwings are small, from less than 1 mm. to about 3 mm. in length, but always more or less reticulated. The forewings have a complete system of cross-veins, though the series of costal veinlets may be incomplete in some of the smaller species. The nymphs are of the crawling type, and may be found under stones, rocks, logs, &c., in either still or running water. Their tail-filaments are long and filiform, not fringed as in the Siphlonuridae and Baëtidae, but only very lightly hairy.

All the Tasmanian species so far discovered belong to the genus *Atalophlebia,* which has its headquarters in Australia and New Zealand. In New Zealand the larger species of the family Leptophlebiidae belong to the genus *Atalophlebia,* the smaller to the genus *Deleatidium*; the only valid difference between them appears to be that the nymphs of the former have double gills, while those of the latter have single gills. I have shown that the supposed difference in the tarsal claws of the adult does not hold (Tillyard, 1934, pp. 4, 7), as the genotype, *A. australis* (Walk.), has the claws similar in shape, each provided with a transparent flange. All the Tasmanian species of which the nymphs are known possess double gills, and must therefore be placed in *Atalophlebia.* The nymphs also all possess denticulate tarsal claws, thus distinguishing them from the nymphs of the South African genus *Aprionyx* Barnard, which is otherwise closely allied to *Atalophlebia.*

The most striking character of the genus *Atalophlebia* is the form of the hindwing (text-figs. 4-9), in which the costal border is always peculiarly humped, the costal space becoming narrowed beyond the hump, and the subcostal space being very broad.

Having previously defined the genus very fully (Tillyard, 1934), and having also given a full description of the genotype, *A. australis* (Walk.), it now only remains to describe the other known Tasmanian species, and to give keys for the separation of the imagos, subimagos, and nymphs, as far as these are known. In order to shorten the descriptions as far as possible, reference will be made to those parts of *A. australis* which have already been fully described and figured in such cases as the corresponding parts of other species only differ slightly from those of the genotype.

It should be noted that the Tasmanian species of *Atalophlebia* can be arranged in two quite distinct groups, one consisting of comparatively large species in which the nymphal gills are digitate, and the other consisting of much smaller species in which the gills are narrowly lanceolate. This distinction will be made use of in the keys.

KEYS TO THE TASMANIAN SPECIES OF THE GENUS ATALOPHLEBIA

I. IMAGOS

1. Larger species, expanding about an inch (forewing from 10 to 13 mm. long)	2
Smaller species, expanding from one-half to three-quarters of an inch (forewing from 5 to 8 mm. long)	6

2. Forewings with two large black spots (each 1 to 1·5 mm. in diameter) near middle, one on costa and one below it, also many smaller spots along and below costa	*A. ida*, sp. nov.
Forewings not spotted	3
3. Forewings with black venation and costal veinlets widely darkened; body black; males with two extremely long tail-filaments, black tipped with white	*A. albiterminata*, sp. nov.
Colour of wings and body brown, orange, or red	4
4. Abdomen distinctly red; tail-filaments usually three, rarely two	*A. australis* (Walk.)
Abdomen brown or orange-brown; tail-filaments two only, stout	5
5. Thorax brown with a mid-longitudinal dorsal orange stripe; abdomen fulvous	*A. hudsoni*, sp. nov.
Thorax dark brown without any orange stripe; abdomen brown	*A. superba*, sp. nov.
6. General colour a medium brown; wings with brown veins ..	*A. brunnea*, sp. nov.
General colour grey or fuscous	7
7. Forewing about 7 mm., rather broad, veins black; general body colouring dark fuscous, the whole insect appearing blackish in life when at rest	*A. fuscula*, sp. nov.
Forewing about 5 mm., long and narrow, veins thin, fuscous; general body colouring medium fuscous	*A. inconspicua* Eat.

II. SUBIMAGOS

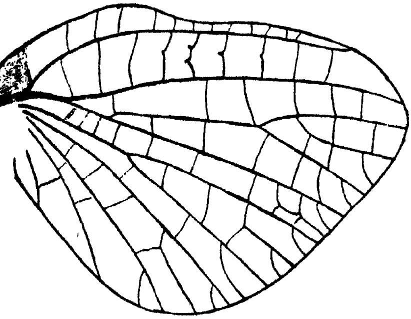
1. Larger species, expanding about an inch (forewing from 10 to 13 mm. long)	2
Smaller species, expanding from one-half to three-quarters of an inch (forewing from 5 to 8 mm. long)	5
2. Forewings pale greyish, marked with two large dark spots near middle and numerous smaller spots along and below costa	*A. ida*, sp. nov.
Forewings dark, with paler areas	3
3. Lambda-mark complete or almost complete (Plate 1, fig. 3) very clearly visible in living insect when at rest; abdomen reddish	*A. australis* (Walk.)
Lambda-mark incomplete, broken up into three or four fragments; abdomen brown or black	4
4. General colour a rich dark brown	*A. superba*, sp. nov.
General colour black	*A. albiterminata*, sp. nov.
5. Forewings pale brownish, slightly mottled	*A. brunnea*, sp. nov.
Forewings grey or fuscous	6
6. Forewing about 7 mm., dark fuscous, appearing almost black in the living insect at rest	*A. fuscula*, sp. nov.
Forewing about 5 mm., much narrower than above, pale greyish, slightly mottled	*A. inconspicua* Eat.

NOTE.—The subimago of *A. hudsoni* sp. nov. is not known.

III. NYMPHS

1. Large nymphs, length of body when full-grown 12 to 16 mm.; gills digitate (Text-figs. 17, 18)	2
Smaller nymph, length of body 7 to 8 mm. when full-grown; gills entire, lanceolate (Text-fig. 19)	*A. fuscula*, sp. nov.
2. General colour very dark brown to blackish; gills wide, multidigitate (Text-fig. 18); three tail-filaments	*A. albiterminata*, sp. nov.
General colour rich brown or reddish-brown	3
3. General colour reddish-brown; tail-filaments three, approximately equal	*A. australis* (Walk.)
General colour rich chocolate-brown; two very stout cerci and a slender, very short appendix dorsalis	*A. superba*, sp. nov.

NOTE.—Of the three smaller species *A. fuscula*, sp. nov., *A. brunnea*, sp. nov., and *A. inconspicua* Eat., only the nymph of *A. fuscula*, sp. nov., has been determined.



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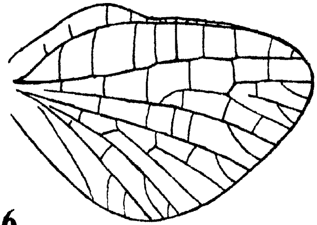

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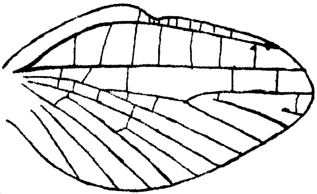

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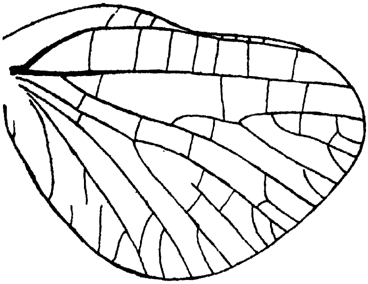

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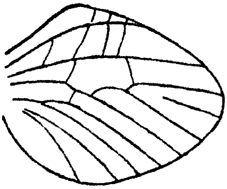

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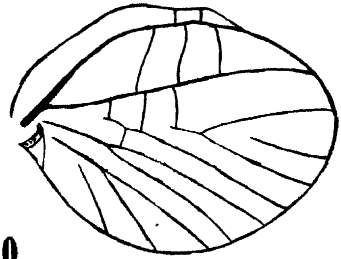

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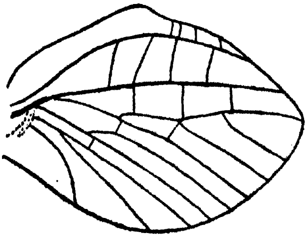

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Figs. 4-10.—Hindwings of the genus *Atalophlebia:*

4. *A. superba* n. sp. (length 4 mm.).
5. *A. hudsoni* n. sp. (length 3·5 mm.).
6. *A. albiterminata* n. sp. (length 3 mm.).
7. *A. ida* n. sp. (length 2 mm.).
8. *A. brunnea* n. sp. (length 1·1 mm.).
9. *A. fuscula* n. sp. (length 1·6 mm.).
10. *A. delicatula* n. sp. (length 1·2 mm.).

Genus **Atalophlebia** Eaton

2. Atalophlebia australis (Walk.)

This species, the genotype, has been fully dealt with by me in Part I. of this series of studies (Tillyard, 1934).

3. Atalophlebia superba, sp. nov.

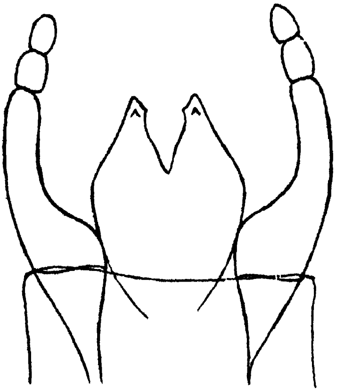
(Plate I, figs. 5, 6; text-figs. 4, 11, 17)

MALE IMAGO: Total length of body (dried) 10-12 mm.; abdomen 6-7 mm; forewing 11-12 mm.

Head: General colour dark chocolate brown, drying almost to black; eyes black; antennae very dark brown.

Thorax shiny, dark chocolate brown, drying almost to black; a pale short stripe on either side of prothorax, brownish or ochreous; underside very dark brown. Legs rich dark brown, the femora blackish apically; forelegs 10 mm. long, the femur and tarsus about equal, the tibia slightly longer; tarsal segments, in descending order of length, 2 = 3, 4, 5, 1 (partly fused with tibia); middle and hind legs much shorter, with order of tarsal segments 5, 2 = 3 = 4, 1 (almost completely fused with tibia); tarsal claws both sharp, with narrow lateral flanges, much as in *A. australis* (Tillyard, 1934, pl. ii, fig. 6).

Wings with strong hyaline membrane, shiny, the veins from dark to medium brown, MA of forewing being the darkest. Bases of both wings clouded with dark brown, the forewing for 2 mm., the hind for less than 1 mm.; costal space of forewing heavily blotched with dark brown as far as the bulla, then more lightly tinted with brown around the pterostigmatic veinlets; basal portions of R_1 and Sc heavily blackened. *Forewing* (Pl. I, fig. 6) more stoutly built than that of *A. australis* (Pl. I, fig. 4), slightly broader, and the veins distinctly thicker, especially MA, the basal portion of CuA, the whole of CuP, and the anal veins. The general venational scheme of the forewing is closely similar to that of *A. australis*, but the posterior branches of CuA are more nearly parallel, and IMP extends further in towards the base than the fork of MA. Further, the wide gaps between the cross-veins shown in *A. australis* below R_2 and MP_1 are not present, and this, being the same in the subimago, causes the breaking-up of the complete lambda-pattern, owing to the development of pigment around the extra cross-veins. *Hindwing* (text-fig. 4) 4 mm. long, 2.5 mm. wide, with the costal hump more pronounced than in *A. australis*, the narrowed portion of the costal space much longer, reaching not



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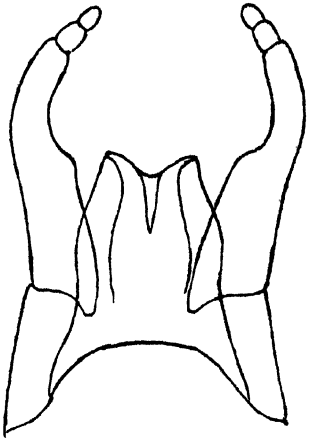

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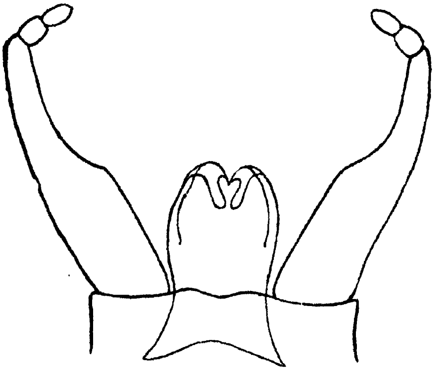

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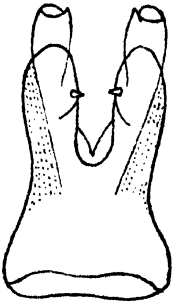

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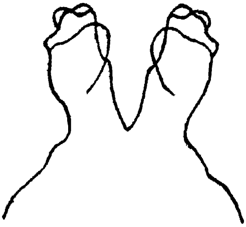

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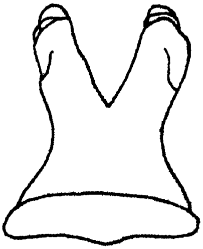

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Figs. 11-16.—Male genitalia of the genus *Atalophlebia*, dorsal views:

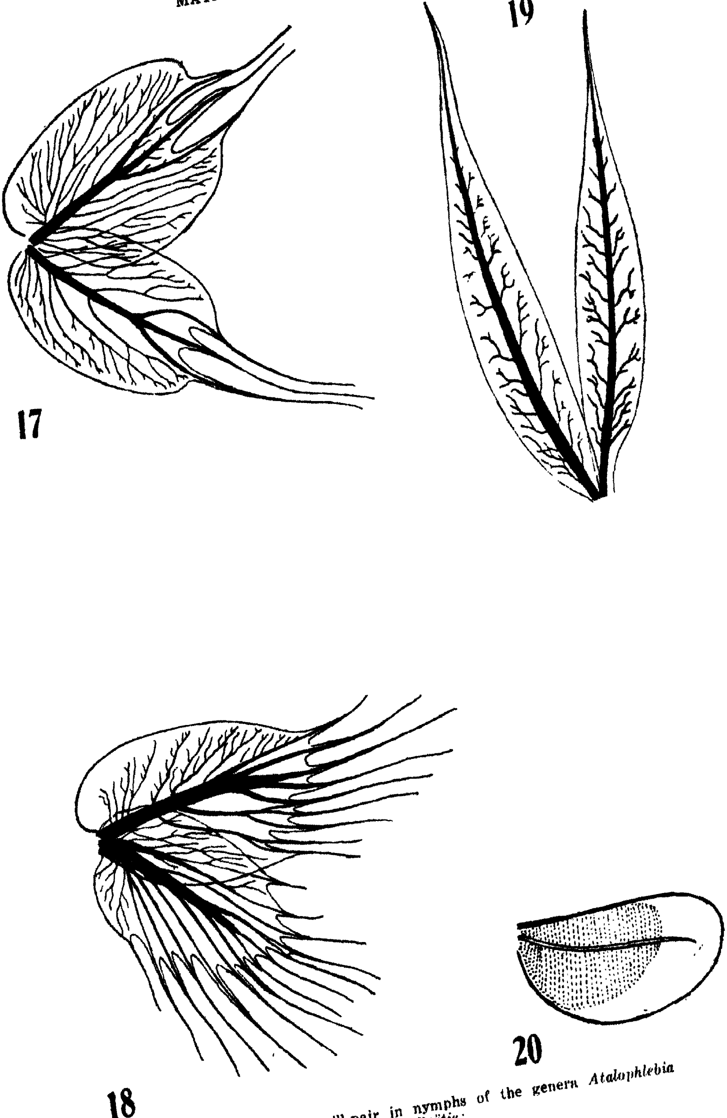
far from apex, with a dozen or more costal veinlets present, two-thirds of them belonging to the narrowed portion; subcostal series of cross-veins complete, with a tendency to the formation of cross-struts between its middle members; Rs arising much closer to base than in *A. australis*; generally a fuller development of cross-veins everywhere in the wing; posterior margin less rounded than in *A. australis*, and with a faint embayment at end of MA.

Abdomen stout basally, dark chocolate brown, ringed with rich medium brown at ends of segments 2-9; spiracles surrounded with circlets of pale brown. *Genitalia* (text-fig. 11) brown, with three-segmented forceps, the first segment long and greatly narrowed for its distal half, the two distal segments nearly equal, short, subglobular; penis large and prominent, broadest near middle, deeply bifid, the two forks each carrying a small inner angle not far from apex, which is fairly sharply pointed also; just below each apex there is also a small denticle. Cerci long, 10-12 mm., brown, ringed narrowly with blackish at end of each segment; appendix dorsalis aborted.

FEMALE IMAGO generally resembling the male, but with much smaller eyes and shorter forelegs; general colour dark brown, the wings not quite as heavily shaded as in the male; prothoracic lateral stripes larger; abdomen generally stouter. A small remnant of the appendix dorsalis usually present, about 0·5 mm. long and very slender; cerci as long as in male. Subgenital plate entire; subanal plate with a median triangular incision.

SUBIMAGO (both sexes) with the general body colouration dark fuscous, distinctly duller than in imago and not shiny; abdomen with pale segmental rings, clearer in male than in female. *Forewings* (Pl. I, fig. 5) heavily shaded with dark fuscous, so as to isolate an incomplete lambda-pattern; the presence of extra cross-veins with shading is the cause of the incompleteness of the lambda-mark. Hindwings shaded heavily with fuscous on all the cross-veins.

NYMPH.—Total length of body 13-15 mm., cerci stout, 8-10 mm.; appendix dorsalis vestigial in male, 0·5 mm., slender, 7-9 mm., long in female but much paler than cerci. General colour dark brown, head and thorax almost black above, the latter with a more or less marked, mid-longitudinal stripe of brown or fulvous on mesonotum. Legs stout, femora dark brown, tibiae and tarsi medium dull fulvous above, all parts dull fulvous below; femur and tibia of equal length, tarsus less than half as long; tarsal claws somewhat stouter and less curved than in *A. australis*, denticulations very



Figs. 17-20.—Fourth gill-pair in nymphs of the genera *Atalophlebia* and *Baëtis*:

17. *A. superba* n. sp. (× 20).
18. *A. albiterminata* n. sp. (× 20).
19. *A. fuscula* n. sp. (× 67).
20. *B. frater* n. sp. (× 100). (Single gill.)

fine. *Gills* (text-fig. 17) seven pairs on segs. 1-7, all double, large and feathery, grey with blackish tracheae; in shape each gill is a broad, rather irregular, oval lamella with the apex trifurcate, each of the three forks being drawn out into a slender filament and provided with a stout trachea; main tracheal trunk stout, subdividing near halfway into three, one branch going into each fork; the main trachea gives off numerous branching tracheae on each side; the narrower of the two gills in each pair has the longest filaments. By comparison with the gills of *A. australis*, these gills are much larger and stouter, with more abundant lateral tracheae, and the apical filaments slenderer.

Types.—Holotype male, allotype female, type male and female subimagos, and type nymph all taken at the Penstock Lagoon, near Great Lake, Tasmania, on 29th January, 1933, by myself. Imagoes both bred from subimagoes; actual date of emergence, 31st January, 1933. All adult types pinned and set; nymph in spirit.

Habitat.—Great Lake, Shannon Lagoon, and Penstock Lagoon, Tasmania.

The nymphs were found in abundance under every piece of rotting wood in the lagoon, and were also dredged up in water-weed and detritus from the bottom. They are rather sluggish, and generally remain quiescent when removed from water; after a while they attempt to run away, and can travel quite fast; they are also quite good swimmers.

The subimago, locally known as the 'Penstock Brown,' emerges in hundreds on the Penstock Lagoon, and in smaller numbers on the Shannon Lagoon and Great Lake. The nymph rises far out in deep water, and the subimago emerges almost as soon as the nymph touches the surface of the water. The wings expand immediately, and the subimago floats on the water like a miniature, brown-sailed yacht. It makes no attempt to fly, but is drifted by the wind towards the shore. If the trout are feeding at the time, many fall easy victims to them; but many more reach the shores of the lagoon, where they at once seek shelter under the bark of near-by trees, under logs and rocks, and down near the roots of clumps of sedge or grasses. The time taken for the imago to emerge is from two to two and a half days.

A good way of ensuring emergence of the imagos is to put a layer of soft moss, not too moist, in a tin billy, and stand upright in the moss a number of stiff stems of sedges. The subimagos can be picked up by their wings and dropped into the billy, when they will at once take up positions on the sedge stems and will remain there until the imago emerges. If the lid is kept on, the humidity of the air inside will be just right to ensure the emergence without deformation.

A large number of paratype imagos, subimagos, and nymphs were secured at the same time as the types.

Var. **pallida.**— A very distinct variety of the subimago was found occasionally at Penstock Lagoon and, later on, more commonly on the Shannon Lagoon. In this the dark parts of the wings are replaced by an almost uniform pale greyish brown, so that the pale portions forming the broken lambda-mark are almost obliterated, and the wings appear very nearly unicolorous. Types of this variety were also taken on 27th January, 1933.

4. Atalophlebia hudsoni, sp. nov.

(Plate I, fig. 9; text-figs. 5, 12)

MALE IMAGO: Closely allied to *A. superba*, which it resembles in general size, form, and coloration. Only the male imago is known; it may be distinguished by the presence of a mid-longitudinal fulvous stripe on the mesonotum, by the different shading of the wings, the different shape of the hindwing, and by the colour of the abdomen.

Forewing (Pl. I, fig. 9) intermediate in colouring, and shading between that of *A. superba* and that of *A. australis;* the base is only moderately tinged with fulvous and the bulla only lightly indicated. The venational scheme comes closer to that of *A. australis* than that of *A. superba. Hindwing* (text-fig. 5), 3·5 mm. long, similar to that of *A. australis*, but somewhat larger and broader.

Abdomen a medium fulvous with darker markings on the spiracles, two interrupted and rather indistinct dorso-lateral darker bands separating a mid-longitudinal paler area, and paler rings around the ends of the segments.

Genitalia (text-fig. 12) rather closely similar to those of *A. australis*, but the forceps is more markedly narrowed after half-way, with a marked bulge on the inner margin; penis broader, more approaching the shape of that of *A. superba*, but with the lobes more like those of *A. australis*, though without the wide pockets seen in that species; instead, there is a deep cleft running backwards from the incision, very narrow. Cerci very long, 20 mm. or more, medium fulvous in colour; appendix dorsalis completely aborted.

Types.—Holotype male imago and three paratype male imagos, taken at Lake Leake, 26th February, 1933, by Mr. Eric Hudson, of Launceston, to whom this species is dedicated. Holotype and two paratypes in spirit; the third paratype dissected and mounted on slides in Canada Balsam.

I saw no sign of this interesting species when I visited Lake Leake on 9th February, so it is evidently late in emerging. As neither the female imago, nor the subimago nor the nymph, is known, we have to rely for the definition of the species purely on the male imago, which appears to me to be in many ways intermediate between *A. australis* and *A. superba*. In view of the fact that nymphs of *A. superba* have been transferred by anglers from the Penstock Lagoon to Lake Leake, with a view to improving the fishing, there seems to me to be a possibility that this form might be a natural hybrid between the two species, which would not otherwise intermingle, as far as is known, anywhere in Tasmania, *A. australis* being apparently confined to the Macquarie River watershed, and *A. superba* to that of the Great Lake and streams connected with it. But unless proof of this is forthcoming, it is better to consider *A. hudsoni* as a valid species.

5. **Atalophlebia albiterminata**, sp. nov.

(Plate I, figs. 7, 8; text-figs 6, 13, 18)

MALE IMAGO: Total length of body 9-10 mm.; forewing 10-12 mm. General colour black, the thorax shiny above, with two fine whitish lines running forward on the mesonotum in front of the insertions of the forewings. Forelegs 8-10 mm. long, slender, blackish, the femora touched with brown in two places; tarsal segments in descending order 2, 3, 4, 5, (partly fused with tibia); middle and hind legs mostly medium brown, the femora strongly marked with black just before middle and for the apical one-fourth, the black and brown areas about equal; tibia blackish basally, brown distally; tarsus dark brown, the segments in descending order 5, 4, 3, 2, 1 (fused with tibia).

Wings hyaline, the *forewing* (Plate I, fig. 8) with black venation, the extreme base faintly yellowish, all the cross-veins in costal and subcostal spaces broadly shaded with black, the bulla carrying a large semi-circular blotch covering about two cellules, with a minute black spot forming a second bulla on R_2; the posterior margin of the forewing is more curved from MA to CuA than in the previous species and the cross-vein system considerably denser; the costa is narrowly basally and the brace-vein comparatively small. *Hindwing* (text-fig. 6) only 2·5 to 3 mm. in length, more triangular than in the previous species; R_1 tends to become slightly bent or broken, MP is very straight, not dichotomously forked; the cross-vein system fairly complete.

Abdomen black, usually with more or less distinct but very narrow pale transverse rings at end of each segment. Genitalia (text-fig. 18) of the general shape of *A. australis*, but with the lobes of the penis much more rounded, the incision between the lobes short, triangular, the pockets quite separate, deep, and divided by a heart-shaped process on a short stalk. Cerci extremely long, 20-30 mm., stout, black, tipped for 3-5 mm. with white; in dried specimens, the ends of the cerci are usually pale buff or brownish; appendix dorsalis absent.

FEMALE IMAGO generally resembling the male, but with smaller eyes and shorter legs, the body stouter and sometimes very dark brown instead of black, the size usually somewhat larger, forewing 11-13 mm. (A female specimen in my collection from Mount Kosciusko expands 28 mm., and is the largest specimen of the genus *Atalophlebia* known to me.) Tail-filaments three, approximately equal, 12-15 mm., the appendix dorsalis slenderer than the cerci.

SUBIMAGO with the general coloration dark fuscous (dull grey in many dried specimens); *forewing* (Plate I, fig. 7) pale greyish, with a more finely mottled pattern than in that of any of the previous species, there being a large number of shaded cross-veins, and the terminal veinlets being more numerous and more heavily shaded; very little of the lambda-pattern can be made out, owing to its being broken up by shaded cross-veins; *hindwing* with all cross-veins shaded, the subcostal series heavily so.

NYMPH: Total length of body 10-13 mm., tail filaments 12-15 mm. General colour either dark brown, dark fuscous, dark grey, or black, according to the colour of the débris in which it is living. *Head* with two very pale, squarish patches between eyes and lateral ocelli and a pale triangular patch on median ocellus; *eyes* black; antennae 3 mm., slender, filiform, multi-articulate, pale greyish brown. Mouth-parts closely resembling those of *A. australis* (Tillyard, 1933, pl. ii, figs. 13-18), but with the following slight differences:—labrum with shallow median incision carrying five distinct, flatly rounded processes; mandibles not quite as broad as in *A. australis*, the incisors longer and more pointed, three in the outer group in each mandible, two in the right inner, one large, sharp one in the left inner; tufts of the prostheca somewhat thicker; maxillae with first and second segments of palp subequal; labium with larger laciniae and with second and third segments of palp equal. *Thorax* almost uniformly dark all over; legs semi-transparent brownish, very strongly particoloured, there being two large dark patches on each femur, one near middle and one occupying the apical fourth, together with an extra basal patch on hind femur; tibia darkened at base and beyond middle, apex pale; tarsus dark from one-fifth to three-fifths from base; tarsal claw with finely denticulate inner margin. *Abdomen* dark, the segments marked with a variable pattern of pale greyish or brownish, which may best be described by stating that the anterior and posterior margins of each segment are pale, and the dark colour appears to be partially divided up into three contiguous blocks whose projecting posterior ends are more or less squarish or sometimes rounded off; tail-filaments medium brownish or fuscous, the principal segments marked off by black rings, but each segment is again subdivided into two, three, or four annulations or subsegments, each very short and only indicated by slightly darkened rings; the more basal segments are short, the more distal much longer. *Gills* (text-fig. 18) pale, greyish, with black tracheae; large, wide, and multi-digitate, with from 7 to 15 slender filaments; the shorter gill is the broader of the two.

Types.—Holotype male imago, allotype female imago, male and female type subimagos and type nymph, all taken on Lake Echo, Tasmania, on 5th February, 1933, by myself, together with a long series of paratypes of both adults and nymphs. Type adults pinned and set, nymphs in spirit; two adult paratypes and two nymphal paratypes dissected and mounted on slides in Canada Balsam.

Habitat.—All over Tasmania and the eastern highlands of Australia, in stagnant or still waters or in backwaters of rivers.

This species is geminate to *A. costalis* Burm., found along the coastline of Eastern Australia (Queensland and N.S.W.), and has closely similar habits. These are the only two species known to me whose nymphs can exist in absolutely stagnant water and appear to prefer it to any other location. The nymphs are usually dredged up with the bottom mud or débris, but are sometimes found in masses of tangled water-weed, or under logs, stones, or rocks in stagnant backwaters; they do not occur where the current is moving at all. The mottled coloration of the legs appears to be 'camouflage'; the multiplication of gill-filaments appears to be correlated with the added difficulty of breathing in stagnant water.

It should be here noted, in passing, that the figure given by me as that of the nymph of *A. costalis* Burm. (Tillyard, 1926, p. 60, fig. E3) is not that of this species, but belongs to a large, undescribed species; the larva of *A. costalis* resembles that of *A. albiterminata* fairly closely and has somewhat similar gills.

As regards the adults, the males may be seen commonly in quiet backwaters, particularly in dull weather or late in the afternoon, performing their graceful evolutions over the water. The flight of the male consists of a long, swinging pendulum motion, usually performed quite close to the water, with the long tail-filaments held out fairly wide apart behind, their white tips being plainly visible. It is seldom that one sees more than six or seven of these insects flying together, often only one or two. They are easily alarmed, and disappear with startling suddenness, apparently becoming suddenly invisible when they swerve away from their swinging flight. The subimagoes may often be seen sitting on the stems of reeds, especially during dull or stormy weather, and can then be easily collected by picking them off with the hand; if the same is attempted with the imago, it usually drops from the reed-stem with a quick motion. The subimagos of this species in Tasmania have the wings more definitely and beautifully mottled than those of the mainland, but there do not appear to be any other differences.

6. **Atalophlebia ida**, sp. nov.

(Plate I, fig. 10; text-fig. 7.)

Female Imago: Total length of body 8-10 mm., forewing 12 mm., cerci about 12 mm. *General coloration* strongly mottled in brown and black. Head (shrivelled) black with bright brown markings. Thorax rich brown shading to black; legs medium brown, with femora black just beyond halfway and also at apex; tarsal segments in descending order, 2 = 3, 4 = 5 (1 fused with tibia).

Forewing (Pl. I, fig. 10) with rather delicate hyaline membrane, dark brown veins, heavily spotted with black; all the costal veinlets and cross-veins in the subcostal space are surrounded by wide oval or rounded black patches, as are also the fewer cross-veins just below R_1, most of those between Rs and MA basally and also between MA and MP. Around the bulla there is a large irregular black patch covering the width of two cellules, and a somewhat similar large patch covers the cross-veins around the fork of MA. Cross-vein system, on the whole, rather open; the wing distinctly narrower than in the preceding four species, with less prominent tornus. *Hindwing* (text-fig. 7) small, barely 2 mm. long, veins delicate, brownish; shape rather elongate oval, the costal hump very pronounced, and followed by a minute notch; costal space comparatively narrow basally and devoid of veinlets; about nine costal veinlets placed distally, three being close together below the notch; subcostal space wide, with complete series of cross-veins, about seven in number; very few cross-veins in posterior portion of wing.

Abdomen mottled in brown and black; in lateral view, the abdomen appears at first sight as if ringed with black on each segment; but, seen more closely, each segment carries a black mark shaped somewhat like a capital R, the loop being small and the lower stroke lengthened. *Tail-filaments* three, subequal, blackish, narrowly ringed with pale brown at end of each segment. Subgenital plate entire, projecting slightly in middle. Subanal plate prominent, projecting beyond end of abdomen, deeply bifid, the two projecting halves pointed, curving inwards distally, and separated by a deep oval cleft.

Male Subimago closely resembling the imago, but with the wings pale opaque greyish; forewing with the spots along the costal and subcostal spaces blackish, but the rest of the mottling only medium grey; tail-filaments three, about 15 mm. long, greyish.

Nymph unknown.

Types.—Holotype female imago, taken at Dee Bridge, between Lakes Echo and St. Clair, Tasmania, on 7th February, 1933, by myself, together with five paratype female imagoes. Type male subimago taken by myself on Lake St. Clair, 6th February, 1933. All pinned and set except one paratype, which was dissected and and mounted on slides in Canada Balsam.

The specific name is taken from Mount Ida, near Lake St. Clair.

Habitat.—Upper reaches of River Dee; also Lake St. Clair, Lakes Lilla and Dove (Cradle Mountain, N.W. Tasmania). The insect was first seen by me on 6th February, drifting far out over Lake St. Clair; several were captured from a boat by striking them down into the water with a net; these were all subimagos, and were mostly badly damaged. The following day the type series was secured by beating bushes overhanging the stream at Dee Bridge; but no male imagos could be found. The specimens from Cradle Mount are considerably smaller (forewing 10 mm.) and less spotted, the patch covering the fork of MA being reduced to a very small size or even to a point, while the rest of the spots on the forewing more closely resemble those of the male subimago described above. The Cradle Mountain series consists of four male and one female imago taken by me in January, 1917; but I prefer to await the discovery of a male imago from the type locality before describing it.

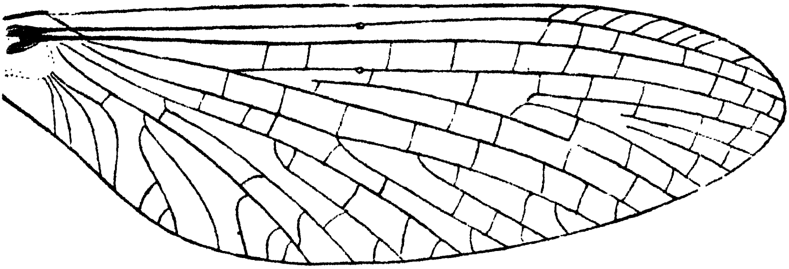


Fig. 21.—*Atalophlebia brunnea* n. sp. Forewing. Length 6 mm.

7. **Atalophlebia brunnea**, sp. nov.

(Text-figs. 8, 14, 21)

Male Imago: Total length of body 6 mm.; forewing 6 mm.; cerci 10-11 mm. General colour brown.

Head dark brown; eyes subdivided into two portions, the larger and upper being pinkish brown, the smaller and lower dark grey; antennae pale; ocelli transparent, whitish, the lateral ones swollen, hemispherical globes on dark brown bases.

Thorax dark brown above, a faint indication of a pair of darker longitudinal stripes on mesonotum. Legs medium brown, knee-joints and ends of tibiae slightly darkened; forelegs 5 mm. long, tarsal segments in descending order of size 2, 3, 4, 5, 1 (partly fused with tibia); middle and hind legs much shorter, tarsal segments in descending order 5, 2, 3 = 4 (1 fused with tibia).

Forewing (text-fig. 21) hyaline with semi-transparent brownish venation, C, Sc, and R_1 darker than the other veins, especially in region of the pterostigma, which is also faintly tinted with brown on the membrane; costal veinlets absent except for a series of about eight in the pterostigma; subcostal cross-veins also absent from base to beyond halfway; rest of venation moderately open; basal portion of anal area with very faint veins; posterior margin before tornus very slightly concave. *Hindwing* (text-fig. 8) very small, 1·1 mm., costa stout, meeting Sc at about three-fifths; costal space without veinlets except for three short ones beyond the hump; four subcostal cross-veins, of which the last two continue the lines of the last two costal veinlets downwards; two cross-veins below R_1 and one blow MA, but no other cross-veins in the wing.

Abdomen pale, semi-transparent brown from base to end of seg. 7; seg. 8 medium brown, 9-10 darker brown; sutures between most of the segments pale, a black spot on each stigma. Genitalia (text-fig. 14) pale buff, with three-segmented forceps, the first segment long, the other two small and globular; penis with slightly diverging lobes separated by a deep semi-circular embayment; each lobe irregularly truncated. Tail-filaments three, equal, pale buff, slightly darker at bases.

FEMALE IMAGO, SUBIMAGO, and NYMPH unknown.

Types.—Holotype male imago and two paratype male imagines, all taken at Clarendon, Northern Tasmania, on the South Esk River, by Mr. Eric Scott, of Launceston, on 9th March, 1933. Holotype and all except tip of abdomen of one paratype in spirit; the other paratype and the cut-off tip of abdomen dissected and mounted on slides in Canada Balsam.

A similar but considerably larger insect was bred by me from a nymph taken in the Shannon River, near the Great Lake, in February, 1933. I also have two specimens rather closely similar to the holotype, taken at Hobart and Mount Wellington respectively in 1917, but these have a faint series of costal veinlets before the pterostigma. Pending the discovery of more abundant material, it seems wise to leave these undescribed.

8. **Atalophlebia fuscula**, sp. nov.

(Text-figs. 9, 15, 19, 22)

MALE IMAGO: Total length of body 7·8 mm.; forewing 7-8 mm.; tail-filaments 10 mm. General colour black.

Head black.

Thorax black: Legs chiefly black, but hind femora mostly dark brown, tending to black at apex; forelegs 6·5 mm., tarsal segments in descending order 2 = 3 = 4 (all fairly long), 5, 1 (partly fused with tibia); middle and hind legs rather long, tarsal segments in descending order 5, 1 = 2 = 3 = 4 (1 fused with tibia).

Wings hyaline, with dark brown venation, rich russet brown at bases of C, Sc, and R of forewing together with brace-vein. *Forewing* (text-fig. 22) with slight fuscous tinting of membrane at pterostigma; costal series of veinlets complete, but very weakly chitinized and widely spaced before pterostigma, there being only about six such veinlets, with about ten much more strongly chitinized and closely spaced in pterostigma; subcostal cross-veins slightly more numerous in basal half, but fewer beneath pterostigma. There are three bullae, in the form of minute circular clear areas in slight swellings of the main veins, as follows: anterior bulla on Sc at about three-sevenths from base; middle bulla on R_2, slightly basad from level of anterior bulla; posterior bulla on R_{4+5}, at junction of cross-vein descending on to fork of MA or close to it, i.e., either at level of anterior bulla or of middle bulla. The anterior bulla usually has slight clouding around it, but the others resemble tiny knots in the veins, with clear holes (membrane) in the middle Anal veins pale. *Hindwing* (text-fig. 9) 1·6 mm., somewhat larger than that of *A. brunnea*, the apex more pointed, the hump somewhat more prominent, the narrow distal portion of the costal space longer, with four veinlets; no veinlets in basal portion of costal space; four long cross-veins in the wide subcostal space, three in the radial, one connecting fork of Rs with MA and one below MA.

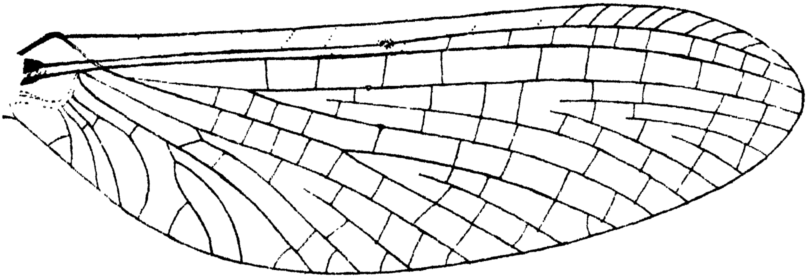


Fig. 22.—*Atalophlebia fuscula* n. sp. Forewing. Length 8 mm.

Abdomen black, marked with a pattern of dark brown, of which the areas decrease in size from seg. 2 to end of abdomen; segs. 2-4 with approximately the basal half dark brown, then the amount of brown decreases until on seg. 8 it is only a narrow basal ring;

segs. 9-10 black, 10 rather large; underside brown. Genitalia (text-fig. 15) with the forceps three-segmented, the first segment very long, narrowed about halfway by a marked inbending of the inner margin; the second segment distinctly longer than the third, subcylindrical, the third globular. Penis turned upwards, its lobes separate, cylindrical, irregularly truncated at apex, which is divided into two blunt lobes, with a third lobe arising on the inner side and not reaching the level of the apex; this inner lobe carries a small, blunt triangular tooth. Tail-filaments three, subequal, about 10 mm long, dark fuscous; very easily broken off.

FEMALE IMAGO closely similar to male, but usually somewhat larger and with stouter abdomen; legs rather long, but forelegs not quite as long as in male. *Forewing* 8 mm.; *hindwing* somewhat larger than in male, with more numerous cross-veins in the posterior portion, there being usually three or four below MA.

SUBIMAGO generally similar to imago, except that the black coloration is much duller; *wings* a medium opaque slate-grey in the pinned specimen, but appearing almost black in the living insect at rest.

NYMPH: Total length of body 7-8 mm.; tail-filaments 10 mm. General colour blackish above, yellowish buff beneath. *Head* blackish tending to dark brown on occiput; eyes grey-black; antennae pale greyish; three pale yellowish or whitish spots cover the ocelli. Mouth-parts differ from those of *A. australis* as follows:—labrum very slightly incised in the middle of the outer margin; mandibles with the incisors much slenderer, ending in two to three teeth in each group, the right mandible with the projecting area far separated from the molar area and ending in a hardened black tubercle; maxillae comparatively short and broad, the inner lobe very wide and not as square in shape as in *A. australis*, the palp comparatively short, the first segment rather broad and almost as long as the second and third taken together, the second cylindrical, the third slightly longer, pointed, with a brush of apical hairs; labium with galea less broad than in *A. australis*, laciniae very small and rounded, palps with the first segment longest and broadest, the other two subequal. *Thorax* dark brown above, mesonotum with two pale yellowish-brown marks above apex, apex itself tipped with blackish; wing-sheaths dark brown (black before emergence); legs somewhat hairy, medium brown, semi-transparent, femora with a dark line along dorsal ridge, longer than tibia, apex fuscous; tibia slender, three-fourths the length of femur; tarsus one-third as long as tibia; tarsal claw small, very strongly denticulate. *Abdomen* rather elongate, tapering from base to anal end, black above, with a mid-longitudinal row of pale yellowish-brown markings, triangular on the more basal segments, but becoming broader and more distinct posteriorly, until on seg. 10 the brown colour covers all but the posterior margin of the segment; seg. 10 with three posterior angles, one at its apex and two postero-lateral; there are also faint indications of a smaller series of brown spots along the sides, one pair on each segment, increasing in size posteriorly; lateral flanges small, hooked posteriorly, semi-transparent yellowish-brown, touched with black at the gill-insertions; underside dull yellowish. *Gills* (text-fig. 19) double, seven pairs, on segs, 1-7, increasing in size from 1 to 4, then decreasing to 7; each lamella is narrowly lanceolate and ends in a long, slender filament; colour pale, semi-transparent brownish, with stout blackish tracheal trunk and short, stumpy lateral tracheal twigs.

Types.—Holotype male imago, allotype female imago, type male and female subimagos and type nymph, also long series of paratypes of both adults and nymphs, taken by myself on the River Shannon, Tasmania, near the bridge on the road leading from the Great Lake to the Penstock Lagoon, on 27th January, 1933.

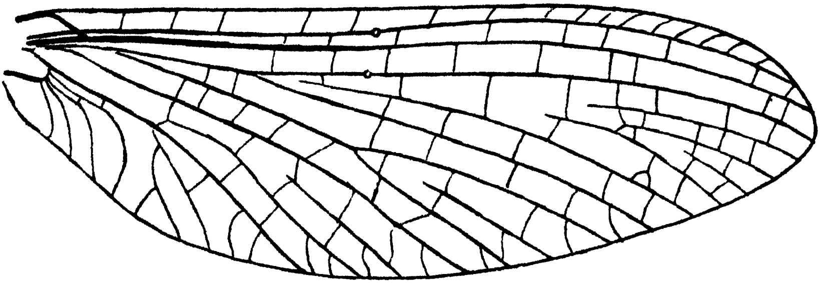


Fig. 23.—*Atalophlebia delicatula* n. sp. Forewing. Length 6 mm.

Habitat.—Fast-running streams in many parts of Tasmania and the highlands of Eastern Australia, including Mount Kosciusko up to about 5000 feet. The imagos may be seen flying in the air in considerable numbers with a typical 'spinning' flight; the subimagos sit about on bushes, reed-stems, &c., and are very conspicuous; they can also be found in numbers hiding on the undersides of large rocks, &c. The nymphs are very active, and cling to the undersurface of rocks in a fast current; when disturbed, they run with great agility.

9 **Atalophlebia delicatula**, sp. nov.

(Text-figs. 10, 16, 23)

Male Imago: Total length of body 5 mm.; forewing 6 mm.; tail-filaments 9 mm. *General colour* blackish.

Head black; eyes large, globular, black; antennae very short, dark brown.

Thorax black; legs long, dark brown, the apices of femora and tibiae blackish; forelegs 5 mm., tibia slightly longer than femur, very slender; tarsal segments in descending order 2, 3, 4, 5, 1 (partly fused with tibia); middle and hind legs fairly long, tarsal segments in descending order 5, 1 (fused with tibia), 2, 3, 4.

Wings hyaline, with delicate, dark brown to blackish venation. *Forewing* (text-fig. 23) 6 mm., brace-vein and bases of C, Sc, and R_1 russet brown; at first sight there are apparently no veinlets in the costal or subcostal spaces until the region of the pterostigma, but, under careful lighting, a few pale, semi-transparent veinlets can be made out (more easily in the female), some of which may be incomplete; about six well-developed slanting veinlets in the pterostigma, with four or five more widely spaced in the subcostal space beneath; there are only two bullae, the anterior just short of midway along Sc, and a second, slightly basad from this level, on R_2; each bulla is a small circular hollow in the vein, with hyaline centre; anal veins pale, anal margin slightly thickened. *Hindwing* (text-fig. 10) 1·2 mm., costal hump rather inconspicuous, not very wide basally, with only two veinlets, both in the short, narrowed distal end of costal space; subcostal space wide, with three cross-veins; bases of Rs and MA missing; one supporting cross-vein above Rs, two above MA, and one below; no cross-veins in posterior half; general shape well rounded.

Abdomen grey-black, with a pattern of greyish markings, only clear on the middle segments, each of which has a pair of pale longitudinal curved lines separating a median dark stripe. Genitalia (text-fig. 16) with the forceps three-segmented, the first segment long, stout basally, tapering strongly distally, the other two segments short, subequal, oval; penis small, its lobes separated by a deep cleft, each lobe stout, irregularly truncated, with three terminal rounded embossments and a larger rounded process projecting slightly inwards not far from apex. Tail-filaments three, subequal, grey, the segments ringed apically with black.

FEMALE IMAGO closely resembling the male, but generally slightly larger, body stouter, forelegs somewhat shorter; forewings usually with a few more pterostigmatic veinlets; subgenital plate entire, subanal plate apparently strongly projecting, slightly truncate at tip and hollowed out.

SUBIMAGOS resemble the imagos, except that the body coloration is a dull greyish black and the wings are slightly opaque pale fuscous, with the cross-veins narrowly shaded in darker fuscous, so as to produce an appearance of mottling, most noticeable in the living insect when at rest.

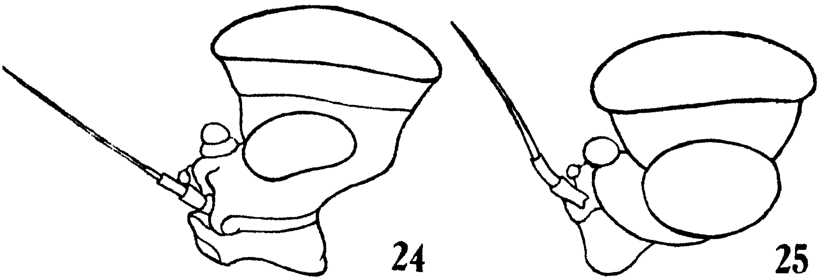
NYMPH unknown.

Types.—Holotype male imago, allotype female imago, type male and female subimagos, also two male paratype imagos and three paratype subimagos, all taken by myself on the North Esk River, near Perth, Tasmania, on 21st January, 1933. All pinned and set.

Habitat.—Northern Tasmania, in moderately flowing rivers. North Esk and Macquarie Rivers. Probably common if searched for.

Family BAËTIDAE

In this family the species are all of rather small size, the forewings being from 4 to at most 12 mm. in length. The hindwings are either absent or excessively small, with very little venation. The most outstanding character in the family is the development of the compound eyes in the males; these are divided into two quite distinct parts, a lower and outer normally oval or rounded part, usually darkly pigmented, and a huge upper and inner portion, raised on a broad pedestal, and known as a 'turban eye' from its marked resemblance to a turban; this part of the eye is usually pale in colour. (See text-figs. 24, 25.)



Figs. 24-25.—Turban-eyes in the males of Baëtidae:
24. Lateral view of head of *Baëtis frater* n. sp. (× 50).
25. Lateral view of head of *Cloëon tasmaniae* n. sp. (× 50).

In the forewing, the cross-vein system is usually (but not always) greatly reduced; the anal system of veins is reduced in correlation with the great reduction or total loss of the hindwing, while, at the same time, the anal area is somewhat broadened and the anal border more or less well rounded. The middle branches of all triads (interpolated veins) are disconnected at their inner ends, except, in some cases, IR_{iii} and ICuA; MA_2 and MP_2 are also usually similarly disconnected. Along the whole of the posterior margin, from CuP to apex, there is developed a complete series of short, marginal veinlets, in between the branches of the main veins; these may be single (Cloëon), or in sets of two or three.

Of the three caudal setae, the middle one (appendix dorsalis) is aborted; the other two (cerci) are usually much longer than the body.

Two cosmopolitan genera are represented in Tasmania, and may be distinguished as follows:—

Hindwing present, exceedingly small; forewing with the marginal veinlets in sets of two or more	Genus *Baëtis* Leach.
Hindwing absent; forewing with the marginal veinlets single	Genus *Cloëon* Leach.

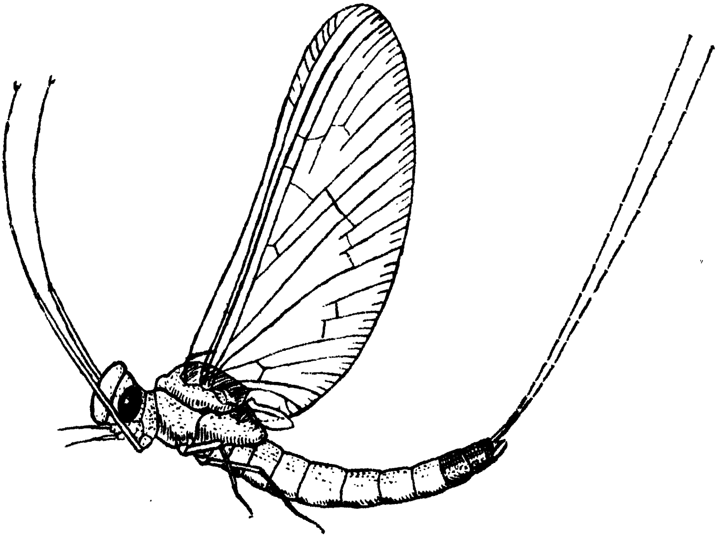


Fig. 26.—*Baëtis frater* n. sp. Male. Complete insect, lateral view, with tail-filaments cut short. (× 11.)

Genus **Baetis** Leach.

10. Baëtis frater, sp. nov.

(Text-figs. 20, 24, 26-28)

MALE IMAGO, Subimago, and Female Imago unknown: Length of body, 4·5 mm.; forewing 4·5 mm.; hindwing 0·6 mm.

Head dark brown; antennae brown; compound eyes dark fuscous, the turban-eyes pale buff; ocelli transparent.

Thorax dark brown. Legs whitish; forelegs 4 mm. long, very slender, tibia twice as long as femur, tarsus one and a half times as long as tibia; segments of tarsus, in descending order of length, 2, 3, 4 = 5, 1; middle and hind legs short, the tarsus only four-segmented, the segments in descending order of length being 1, 2 = 4, 3.

Forewing (text-fig. 26) 4·5 mm. long by 1·6 mm. wide, hyaline with white veins and slightly opaque, cream-coloured pterostigma. Venation as in text-fig. 26; from seven to nine pterostigmatic veinlets, irregularly placed, the first two or three very faint; two cross-veins between R_1 and R_2; and two below R_2 basal ends of R_{3a} and IR_{3b} connected with main veins above and below; a cross-vein joining IR_{3b} to MA_1 across R_{4+5}; faint cross-veins below basal ends of IMA, MA_2, IMP and MP_2; ICuA connected basally with CuA and CuP. Marginal veinlets in sets of two. *Hindwing* (text-fig. 27) excessively reduced, 0·6 mm. long, with a strong costal knob or hump, one fairly strong vein (R_1) and four very weak veins.

Abdomen slender, segments 1-6 lightly chitinized, pale, whitish, a tinge of pale brown on tergites; segments 7-10 much more heavily chitinized, dark brown. Genitalia with the limbs of the forceps four-segmented; the basal segment short and broad, the second and third not very clearly separated, slender and much longer, the fourth small, narrow pyriform. Penis retracted, its lobes broad, flattened, rather bluntly pointed. *Cerci* 3 to 4 mm. very slender, with about 50 cylindrical segments, mostly 5 to 6 times as long as wide.

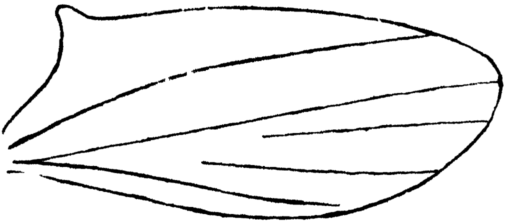


Fig. 27. *Baëtis frater* n. sp. Hindwing. (× 100.)

NYMPH (text-fig. 28): Length of body 6 to 7 mm.; cerci 3 to 4 mm., antennae 3 mm., pale buff, with more than 30 segments; appendix dorsalis slightly shorter. General colour a medium brown, the head somewhat darker, the eyes dark-grey; mouth-parts and legs pale buff; last segment of abdomen and tail-filaments pale buff; gills semi-transparent tinged with buff. There is a slight pattern dorsally on the thorax, consisting of a pale mid-longitudinal line, bordered on each side by a narrow stripe of dark brown, which is joined posteriorly by a more laterally placed, oblique, broader dark stripe on each side. The extreme base of each abdominal segment is narrowly ringed in pale buff. The mouth-parts, femora, tibiae, and tarsi are touched distally with fuscous. Viewed laterally, the abdominal tergites are dark brown, the sternites pale buff. Legs short, with rather stout femora, slender tibiae somewhat shorter than femora, tarsi about same width as tibiae but shorter. Gills (text-fig. 20) seven pairs, on abdominal segments 1-7, the first pair very small, the third and fourth pairs largest, those of segs. 6 and 7 much smaller than 5; each consists of a single oval lamina, of which the outer (anterior) margin is fairly straight, the inner well rounded; each carries a single tracheal trunk, situated somewhat closer to the anterior than to the posterior margin; the anterior and basal parts of the lamella are of tougher consistency than the inner and distal, and are darkened with a fine brownish granulation; both anterior and inner margins are somewhat thickened, especially the former. The cerci are narrowly fringed on the inner side only, the appendix dorsalis is similarly fringed on both sides.

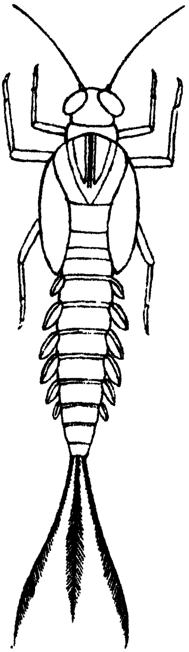


Fig. 28.—*Baëtis frater* n. sp. Full-grown nymph (male). Length, excluding tail-filaments, 6 mm.

Types.—Holotype male imago and type nymph, both taken together by myself on a small creek near Weldborough, North-Eastern Tasmania, together with numerous paratypes of male imagos and nymphs. All in spirit. The adults were flying in small groups a yard or two above the water; the nymphs rested on the sandy or gravelly bed of a fairly fast-running creek.

This species appears to be rather closely related to *B. soror* Ulm, from Western Australia, but can be at once distinguished from it by its smaller size, pale abdominal segments 1-7, and pale costa and subcosta without any darkening of the costal and subcostal spaces. In the venation, *B. soror* has a much more extensive series of costal veinlets occupying the whole of the distal half of the costal space, and the marginal veinlets are single along the basal half or more of the posterior margin, then double to apex. The hindwing in *B. soror* has the costal projection ending in a sharp angle, not in a rounded hump as in the new species. Also the cerci in *B. soror* are faintly ringed with dark at the end of each segment.

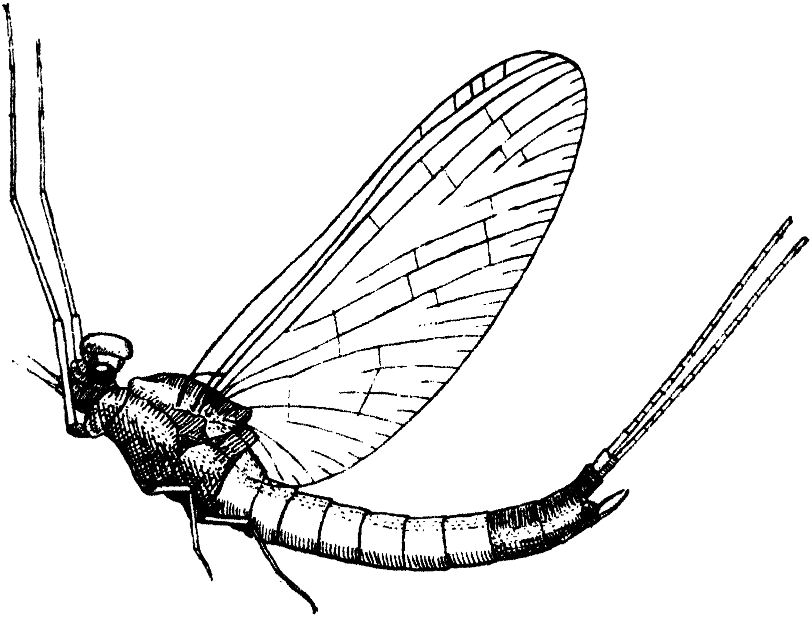


Fig. 29.—*Cloëon tasmaniae* n. sp. Male. Complete insect, lateral view, with tail-filaments cut short. (× 11.)

Genus **Cloëon** Leach.

11. **Cloeon tasmaniae**, sp. nov.

(Text-figs. 29, 30)

Male Imago (text-fig. 29) : Length of body 7 mm., forewing 6 mm., cerci 12 mm., foreleg 5·2 mm.

Head pale brown; antennae whitish; compound eyes dark fuscous, the turban-eyes pale buff tinged with pink.

Thorax medium brown, paler beneath. Legs whitish; foreleg with femur about 1·2 mm. long, not very stout, tibia 1·6 mm., slender, tarsus 2·2 mm., the segments in descending order of length being 2, 3, 4, 5, 1; middle and hind legs short, segs. 1 and 2 fused together; in descending order the lengths of the segments are 1 + 2, 3 = 5, 4.

Forewing (text-fig. 29) 6 mm. long by 2·4 mm. wide, hyaline (except for the costal and subcostal areas, which are opaque) pale cream-coloured, deepest on pterostigma; veins very pale buff, except R_1, which is whitish except at its distal end. Pterostigma with about five veinlets well spaced apart. Branches of main veins all disconnected basally, but supported by a number of cross-veins arranged as shown in text-fig. 29. Marginal veinlets single. *Hind-wing* absent.

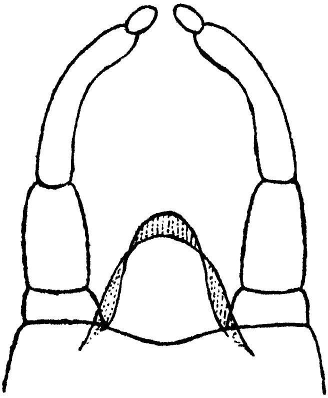


Fig. 30.—*Cloëon tasmaniae* n. sp. Male genitalia, dorsal view. (× 100.)

Abdomen pale yellowish brown darkening to medium brown on segs. 7-10; no definite pattern. Genitalia (text-fig. 30) whitish, the limbs of the forceps four-segmented, the first segment short and stout, the second somewhat longer, fairly stout, the third slenderer, thrice as long as the first, the fourth a minute knob; penis a pair of minute projecting lobes, barely visible. Cerci extremely long and slender, 12·5 mm., with more than forty segments, whitish, the joints slightly darkened; appendix dorsalis vestigial.

Female Imago generally of same size as male, but differing in its slightly darker coloration, the head and thorax being somewhat darker brown; no turban eyes present; cerci and forelegs shorter.

Subimago (both sexes) similar to imago in general form and size, but with general body-colouring pale creamy buff; compound eyes fuscous, ringed with creamy white; turban-eyes of male smaller than in imago, cream-coloured. Wings with the membrane slightly opaque, milky white, the veins whitish.

Nymph unknown.

Types.—Holotype male imago and allotype female imago from the Macquarie River, Stewarton, Tasmania, 8th February, 1933, taken by Mr. Eric Scott; type subimagos, male and female, from same locality, 5th March, 1933, taken by Mr. B. Plomley. Also a series of paratypes, three male imagoes, and eight subimagoes.

This interesting species of a cosmopolitan genus is the first purely Australian species of the genus *Cloëon* to be described, the other being *C. viridis* Klap., found in Java, Sumatra, and North-Western Australia. A species closely allied to *C. tasmaniae* n. sp. is known to occur also in the mountains of Eastern Australia, but has not yet been described. *C. tasmaniae* n. sp. agrees with all the Indo-Malayan species in having the costal and subcostal areas of the forewing distinguished from the rest of the wing by special coloration, but not so markedly, for instance, as in *C. viridis* Klap. or in *C. samoënse* Till. The creamy-buff subimagoes are very striking.

Family CAENIDAE

(*Brachycercidae* Lestage)

It should be noted that Lestage has changed the spelling of *Caenis* Leach to *Coenis*, and, later, has suppressed this name as a synonym of *Brachycercus* Curtis, at the same time changing the well-established family name to Brachycercidae. As no other authors have followed him in these alterations, I propose to keep to the name *Caenis*, pending a full investigation of the problems of nomenclature involved.

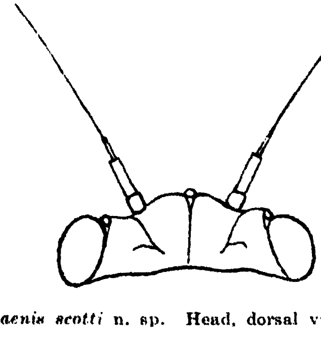


Fig. 31.—*Caenis scotti* n. sp. Head, dorsal view. (× 67.)

In this family the species are all of small to very small size, some being the smallest known Mayflies, the forewing of one species being only 2 mm. long. The hindwings are absent in almost all cases. The family can be at once distinguished from the Baëtidae by the form of the compound eyes (text-fig. 31), which are button-like and placed wide apart in both sexes. The anal area of the forewing is expanded and well rounded, usually even more so than in the Baëtidae, and there is usually only a single anal vein, more rarely two. The branches of the main veins, including the middle members of triads, are either all or mostly complete basally; the cross-vein system is greatly reduced (almost entirely absent in *Caenis* itself). The nymphs (not yet discovered in Tasmania) have shorter and somewhat stouter bodies than the nymphs of Baëtidae, and can be distinguished at once by the fact that the gills of the second segment of the abdomen form a pair of stiff gill-covers or opercula, completely protecting the succeeding pairs of gills on segments 3 to 6. The caudal filaments are stiff, filiform, hairy, but not fringed as in Baëtidae.

The two Tasmanian genera may be distinguished as follows:--

Wings not exceptionally broad; ratio of length to breadth approximately 3 : 1	Genus *Tasmanocoenis* Lestage
Wings exceptionally broad near base; ratio of length to breadth 2 : 1 or even less	Genus *Caenis* Leach

Genus **Tasmanocoenis** Lestage

This genus has the wings only slightly dilated in the anal region; A_1 stands well apart from CuP basally, but the latter vein curves distally towards it again; A_1 itself is slightly sigmoid. Lestage gives no figures, so it is difficult to picture what the insect is like.

Genotype.—Tasmanocoenis tonnoiri Lestage.

12. **Tasmanocoenis tonnoiri** Lestage

This small Mayfly, with a forewing 5 mm. long, was described from a single male imago taken by Mr. A. L. Tonnoir at Geeveston, Tasmania, on 7th December, 1922. The type is in Brussels.

Genus **Caenis** Leach.

13. **Caenis scotti**, sp. nov.

(Text-figs. 31-33.)

MALE IMAGO: Length of body 3·4 mm.; forewing 3·4 mm.; foreleg 2·6 mm.; caudal filaments about 9 mm.

Head short, wide, more than thrice as wide as long; compound eyes black, placed laterally, almost as long as the head itself; median ocellus small, on a slight median prominence in front; lateral ocelli also small and contiguous with the inner margin of the compound eyes; antennae pale brownish, about as long as the head is wide, the scape short and stout, the pedicel about twice as long, fairly stout, the first distale stiff, slender, about half as long as the pedicel, the remainder of the antenna consisting of an extremely delicate, transparent filament.

Thorax extremely large and stout, heavily chitinized, dark brown to blackish. Prothorax short, not quite as wide as head; ventrally it carries an inverted V-shaped mark, edged posteriorly with a black line. Mesothorax immense, occupying almost the whole of the thorax; metathorax very short, attached closely to mesothorax behind; sternites pale. Legs pale brownish; forelegs 2·6 mm., femur rather short, tibia and tarsus each about thrice as long as femur; lengths of tarsal segments in descending order 2, 3, 4, 5, 1; middle and hind legs much shorter, tarsal segments in descending order of length 1, 5, 2, 3 = 4; tarsal claws alike in foreleg, both globular, unlike in middle and hind legs, one blunt and one sharp.

Forewing (text-fig. 32) 3·4 mm. long by 1·8 mm. wide; completely hyaline, except for pterostigma, which is milky; veins white, except Sc and R_1, which are dark purplish to pterostigma. Venation typical for the genus (text-fig. 32); all the branches of the main veins complete basally; IR_2 attached basally both above and below; R_3 arising from IR_2; IMA arising from MA_1, IMP from MP_2. Two short subcostal cross-veins are present near middle of Sc; the first of these is continued obliquely backwards and downwards to R_3; about one-third from base, there is a cross-vein between IR_2 b and R_{4+5}, and another joining MA_2 near its origin to MP_1; still closer to base, the posterior fork of CuA is joined by a cross-vein to CuP. CuP and A_1 between them isolate a narrow, bottle-shaped area with bent neck. *Hindwings* absent.

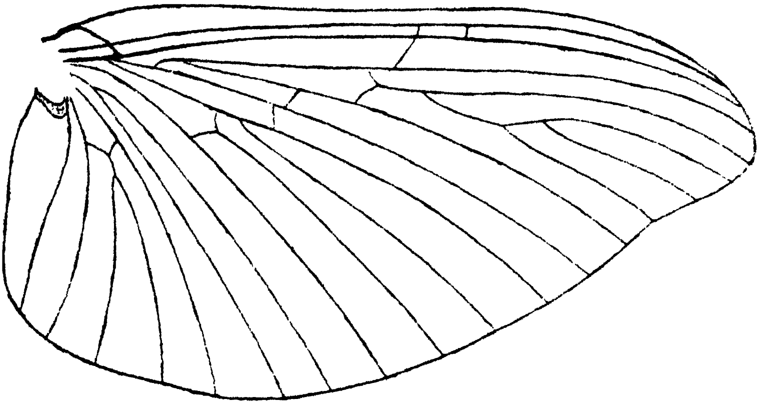


Fig. 32.—*Caenis scotti* n. sp. Forewing. Length 3·9 mm.

Abdomen short, stout basally, tapering from segment 1 to 4, then cylindrical to 9; 10 narrower, closely attached to 9. Colour pale to medium brown, segs. 8-10 much darker. Genitalia as in text-fig. 33, the limbs of the forceps with only a single segment, curved, sharply pointed, calliper-like; the penis with its two lobes fused to form a projecting, broadly rounded organ, flattened dorsoventrally, dark brown basally, transparent distally and along both sides. Caudal filaments three, about equal, 9 mm. long, with about 40 long, slender cylindrical segments, followed at the extreme tips by a few very short, partly fused segments carrying long hairs.

FEMALE IMAGO, SUBIMAGO (both sexes), and NYMPH unknown.

Types.—Holotype male imago and series of six paratype male imagoes taken on the South Esk River at Clarendon, Tasmania, on 9th March, 1933, by Mr. Eric Scott, to whom the species is dedicated. Holotype mounted whole on slide in Canada Balsam; one paratype dissected and similarly mounted, the other five in spirit.

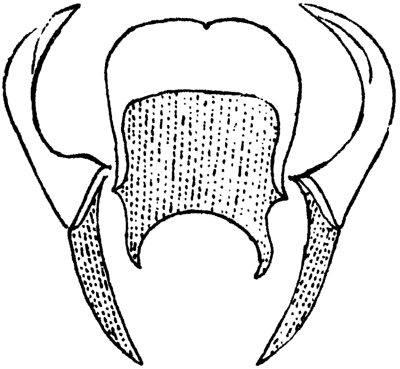


Fig. 33.—*Caenis scotti* n. sp. Male genitalia. (× 100.)

A very striking and distinctive species, easily recognized by the purple coloration of Sc and R_1 in forewing combined with the milk-white pterostigma, and by the tuft of long hairs at the end of each caudal filament. There is a similarly coloured, but much smaller, species in the mountains of Eastern Australia, not yet described.

SUMMARY

The paper forms Part II. of the 'Trout-food Insects of Tasmania,' and is intended to be read with Part I., in which *Atalophlebia australis* (Walker), the long-lost genotype of the genus *Atalophlebia*, was fully discussed and described. Part II. is a Monograph of the Mayflies of Tasmania, as far as at present known. A total of thirteen species is listed, of which no less than eight belong to the genus *Atalophlebia*. There are only four families represented, as follows:—Siphlonuridae (*Tasmanophlebia*, one species, previously known); Leptophlebidae (eight species, all belonging to *Atalophlebia*, one known previously, seven new); Baëtidae *Baëtis*, one species, and *Cloëon*, one species, both new); Caenidae (*Tasmanocoenis*, one species, previously known, and *Caenis*, one species, new). The nymphs of seven of the species are known. The paper is illustrated with a plate showing ten forewings (imagoes and subimagoes), together with thirty-three text-figures.

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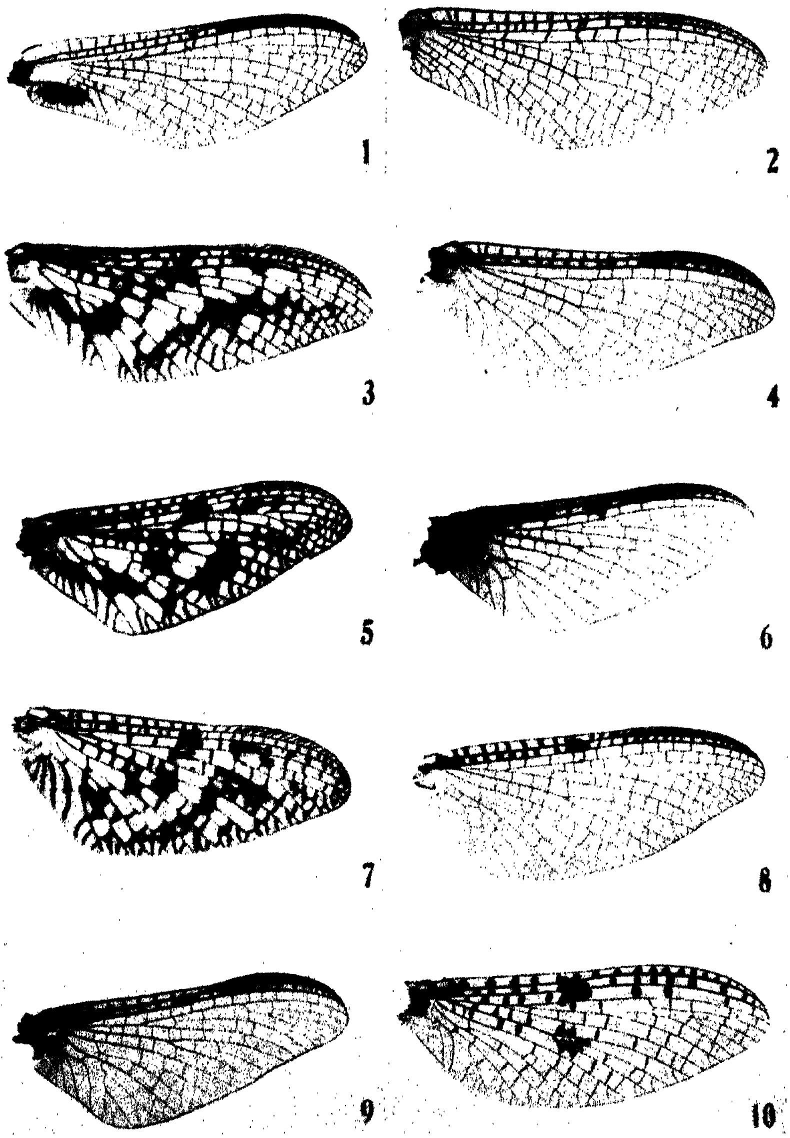
EXPLANATION OF PLATE

PLATE I.—Photographic Enlargements of the Forewings in the Genera *Tasmanophlebia* (figs. 1, 2) and *Atalophlebia* (figs. 3-10):

Fig. 1. *Tasmanophlebia lacustris* Till. Male Imago.
Fig. 2. *Tasmanophlebia lacustris* Till. Female Imago.
Fig. 3. *Atalophlebia australis* (Walker). Subimago.
Fig. 4. *Atalophlebia australis* (Walker). Imago.
Fig. 5. *Atalophlebia superba* n. sp. Subimago.
Fig. 6. *Atalophlebia superba* n. sp. Imago.
Fig. 7. *Atalophlebia albiterminata* n. sp. Subimago.
Fig. 8. *Atalophlebia albiterminata* n. sp. Imago.
Fig. 9. *Atalophlebia hudsoni* n. sp. Imago.
Fig. 10. *Atalophlebia ida* n. sp. Imago.



Photographic Enlargements of the Forewings in the Genera *Tasmanophlebia* (figs. 1, 2) and *Atalophlebia* (figs. 3-10).

PAP. & PROC. ROY. SOC. TAS. 1935 (17TH AUGUST, 1936).

The Bythoscopidae of Australia (Homoptera, Jassoidea)

By

J. W. EVANS, M.A., F.R.E.S.

PLATES II-IV

In all works dealing with the classification of the Jassoidea, the Bythoscopidae are defined as leaf-hoppers that have their ocelli situated on the ventral surface of their heads and without a distinct margin between vertex and frons. A study of *Eurymela* Le P. and Serv. and related genera, supplied evidence that these genera, although comprised of insects that all have their ocelli ventrally placed, are not closely related to other Bythoscopid genera. Accordingly they have been placed in a separate family (Evans, 1934).

Whilst the Eurymelidae are a homogeneous group, that have as well as common structural characters, similar life-histories and habits, the Bythoscopidae appear to comprise a heterogeneous collection of genera, bound together by a common structural character, the ventral position of the ocelli. It is doubtful whether this character is of any great phylogenetic significance, or whether the majority of the genera are particularly closely related to each other. The presence or absence of a distinct margin between vertex and frons is a character of no value when applied to Australian forms. However, until more material is available, and further research concerned with both the morphology and habits of these insects carried out, it is convenient to retain the family as a unit.

In none of the taxonomic papers in which Australian leaf-hoppers have been described, that have appeared since 1907, has any attempt been made to revise Kirkaldy's classification, though all who have attempted to identify insects with the aid of his bulletins will agree that revision is needed.

This paper is one of a series dealing with the Australian Jassoidea. In each paper an attempt is being made to bring together all known Australian species that belong to the group under consideration. It is perhaps unfortunate that the Palaearctic Jassoid fauna was the first to be thoroughly studied, since the classification of other faunas has had of necessity to be based on this. If the Australian fauna had received similar attention in the past it is believed that a better understanding would now be had of the whole Jassoid complex.

Kirkaldy (1906), referring to the Australian region, pointed out that it demanded the attention of hemipterists, since it appeared to possess the oldest existing fauna in the world. His prediction that the classification of other faunas would have to be modified when the Australian fauna had been worked out, will doubtless prove correct.

KEY TO THE GENERA OF AUSTRALIAN BYTHOSCOPIDAE.

1.	Head, including the eyes, wider than the pronotum at the base; bases of tegmina lying close behind the eyes	2
	Head, including the eyes, narrower than the pronotum at the base; bases of tegmina not lying close behind the eyes	8
2.	Tegmen with a wide appendix	3
	Tegmen with a narrow or no appendix	4
3.	Tegmen with sub-apical cells	*Idiocerus* Lewis Type *Idiocerus adustus* Lewis
	Tegmen without sub-apical cells	*Pedioscopus* Kirk. Type *Pedioscopus philenor* Kirk.
4.	Ocelli nearer to the eyes on each side than to each other; or the distance between the ocelli equal to the distance between each ocellus and the adjacent eye	5
	Ocelli nearer to each other than to the eyes on each side	*Austroagallia*, gen. nov. Type *Austroagallia torrida*, sp. nov.
5.	Ventral surface of head more or less flat; maxillary plates narrow	6
	Ventral surface of head more or less in two planes; maxillary plates wide	*Austroagalloides*, gen. nov. Type *Austroagalloides karoondae*, sp. nov.
6.	Width of head equal to, or but little greater than, the length	7
	Head, including eyes, nearly twice as wide as long	*Stenoscopus* Evans Type *Stenoscopus drummondi* Evans
7.	Striations on pronotum transverse	*Oncopsis* Burm. Type *Cicada flavicollis* L.
	Striations on pronotum oblique	*Macropsis* Lewis Type *Cicada virescens* Lewis
8.	Crown of head from above visible narrowly between the eyes; pronotum steeply declivous	9
	Crown of head from above visible widely between the eyes; pronotum not steeply declivous	*Eurinoscopus* Kirk. Type *Eurinoscopus lentiginosus* Kirk.
9.	Ventral surface of head evenly rounded	*Chinaella*, gen. nov. Type *Chinaella argentata*, sp. nov.
	Ventral surface of head not evenly rounded, the clypeus lying almost at right-angles to the vertex	*Trocnada* Walk. Type *Trocnada dorsigera* Walk.

In the majority of the descriptions of new species that follow, the colour pattern of the type is not given in great detail, since two individuals are seldom found that have identical markings. Instead numerous figures are given, in the hope that they will assist to render the descriptions intelligible.

Tribe MACROPSINI

This tribe is erected to hold the following genera: *Macropsis* Lewis, *Oncopsis* Burm., and *Stenoscopus* Evans. These genera, of which the last is represented by a single species occurring in Western Australia, are very similar to each other in general appearance and detailed structure.

Genus **Macropsis** Lewis

Trans. Ent. Soc. London 1 : p. 49, 1835.

This genus is of world-wide distribution, and according to China (1925) contained in 1925 nearly seventy described species. Five species have been described previously from Australia: *abscondens* Walk. (*Bythoscopus*), (*Homopt. Ins. Suppl.*, p. 267, 1858); *ocroe* Kirk., *thymele* Kirk., *thyia* Kirk., and *thontias* Kirk. (*Bull. Hawaii. Sug. Ass. Ent.* 3; p. 36, 1909). Ten new species are described below. It is possible that a study of the food plants of *Macropsis* spp. would show that many of the species feed upon a single species of plant, since such an isolation would account for the many closely related forms that have developed. The figures render a redescription of this genus unnecessary. The presence of oblique striations on the pronotum is a character that enables its separation from *Oncopsis*, in which the striations are transverse. The male genitalia of all members of the Macropsini consist of long and narrow parameres and subgenital plates, that are frequently of almost equal length to each other, and an aedeagus of variable shape.

Macropsis occidentalis, sp. nov.

(Plate II, fig. 2)

Length, 4 mm. (from the apex of the head to the tip of the folded tegmina).

Head, width 1 mm., punctate, almost flat, with a slight median ridge on the vertex; hind margin produced dorsally; from above angularly produced, the crown (here considered as that part of the vertex as is visible from above) only visible at the sides against the eyes. Frons ochreous, the rest of the head greenish and ochreous, but for two diffuse black areas on the vertex; eyes reddish-brown.

Pronotum, punctate, pale greenish-brown, steeply declivous anteriorly, and higher in the middle than at the sides. *Scutellum*, smooth, yellowish; apex green. *Tegmen*, transparent, tinted slightly with yellowish-green; appendix small, barely perceptible.

Thorax and *abdomen*, ventral surface pale green. *Legs*, pale yellowish-green; tarsi, pale brown.

Type ♀, from Bruce Rock, Western Australia (coll. F. Drummond), in the collection of the Australian Museum, Sydney.

Macropsis victoriensis, sp. nov.

(Plate II, figs. 1a, 1b, 1c)

Length, 4·5 mm. General coloration, greenish-yellow.

Head, width 1·2 mm., egg-yellow, eyes pale chocolate-brown; posterior margin of vertex angularly produced; crown from above visible for its entire width, wider against the eyes than in the middle.

Pronotum, olive-green, anterior lateral angles, yellow. *Scutellum*, yellow. *Tegmen*, clavus and costal margin, apple-green; costal area, colourless, transparent; apex, smoky grey.

Thorax and *abdomen*, ventral surface, yellowish. *Legs*, yellowish but for the hind tibiae, which are green.

Type ♂, from Burwood, Victoria (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Macropsis federalis, sp. nov.

(Plate II, fig. 3)

Length, 3·8 mm. General coloration, apple-green.

Head, width 1·2 mm., greenish-yellow, with two small brown markings below the ocelli; eyes reddish-brown, hind margin of head rounded; crown visible from above only as a narrow border against the eyes on each side.

Pronotum, pale green, the anterior margin angularly produced, so that in the centre it reaches beyond the posterior border of the head. *Scutellum*, yellowish-green, punctate. *Tegmen*, apple-green, but for the costal area and apex, which are colourless; appendix relatively wide.

Thorax, ventral surface yellow, with dark brown markings. *Legs*, pale yellow. *Abdomen*, ventral surface pale canary yellow.

Type ♀, from Canberra, F.C.T. (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Macropsis filicis, sp. nov.

(Plate II, fig. 4)

Length, 3·2 mm. General coloration, yellowish-green.

Head, width 1 mm., lemon-yellow, ocelli brown, eyes chocolate-brown; crown from above visible as a band of even width between the eyes.

Pronotum, green, slightly declivous. *Scutellum*, yellow. *Tegmen*, yellowish-green, but for the apex, which is white.

Thorax and *abdomen*, ventral surface and *legs* very pale green.

Type ♀, from Fern Tree Gully, near Melbourne, Victoria (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Macropsis tasmaniensis, sp. nov.

(Plate II, fig. 5)

Length, 3 mm.

Head, width 1·2 mm., very pale yellowish-brown with dark brown punctures, and two very dark brown arcuate markings on the frons; eyes dark brown; crown from above visible as a wide border between the eyes, of equal width throughout.

Pronotum, almost flat; greyish-brown with dark brown punctures, and two dark brown oval markings against the anterior border, laterally. *Scutellum*, yellowish-brown with brown punctures. *Tegmen*, hyaline, clavus grey; veins brown, barred with white.

Thorax and *abdomen*, ventral surface dark brown. *Legs*, dark brown, but for the bases of the spines on the hind tibiae, which are black, and the first tarsal segment of the hind tibiae, which is very pale brown.

Type ♀, from the summit of Mount Wellington, Hobart, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

Macropsis luteus, sp. nov.

(Plate II, fig. 6)

Length, 3·2 mm.

Head, width ·8 mm., somewhat convex; pale yellowish-brown with dark brown punctures, and two khaki coloured arcuate scars on the lateral borders of the frons; crown from above, visible as a wide band between the eyes, of equal width throughout.

Pronotum, pale yellowish-brown with brown punctures. *Scutellum*, anterior two-thirds, concolorous with the pronotum, the apical third smooth, pale yellowish-white. *Tegmen*, transparent, veins brown with white bars, appendix narrow.

Thorax, ventral surface, pale yellowish-white with black markings. *Legs*, pale yellowish-brown, but for the bases of the spines on the hind tibiae, which are black; spines strong. *Abdomen*, ventral surface, pale yellowish-brown.

Type ♀, from Bruce Rock, Western Australia (coll. F. Drummond), in the collection of the Australian Museum, Sydney. This species has also been taken in the neighbourhood of Adelaide, South Australia.

Macropsis hobartensis, sp. nov.

(Plate II, fig. 7)

Length, 4 mm.

Head, width 1·2 mm., entirely ochreous; crown from above entirely visible, wider against the eyes than in the centre.

Pronotum, dull olive-green, the anterior lateral angles paler than the rest of the pronotum. *Scutellum,* yellow, with two brown triangular shaped markings against the anterior margin. *Tegmen,* transparent, veins colourless.

Thorax and *abdomen,* ventral surface, and *legs,* pale yellowish-brown.

Type ♀, from Hobart, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

Macropsis lincolnensis, sp. nov.

(Plate II, fig. 8)

Length, 4 mm. General coloration, pale yellowish-brown.

Head, width 1·1 mm., pale biscuit colour with brown punctures and two oval ochreous markings just above the ocelli; eyes light brown; crown from above not visible in the centre.

Pronotum, light brown with dark brown spots, the anterior border smooth and yellow behind the eyes, the posterior two-thirds darker in colour; steeply declivous, so that the anterior margin is almost at right angles to the hind margin. *Scutellum,* ochreous, sparsely punctured with brown. *Tegmen,* clavus hyaline, grey, the rest of the tegmen colourless, transparent; anal veins buff, the other veins brown.

Thorax and *abdomen,* ventral surface, and *legs,* pale brown.

Type ♀, from Port Lincoln, South Australia (coll. A. M. Lea), in the collection of the South Australian Museum.

Macropsis flindersi, sp. nov.

(Plate II, fig. 9)

Length, 4·5 mm.

Head, width 1·5 mm., pale yellow and grey, with a few small scattered light brown spots and two brown oval markings just above the ocelli; eyes, pale brick red; crown of head from above visible only as a narrow border between the eyes.

Pronotum, declivous; grey flecked with brown spots, and two oval yellow areas against the anterior border laterally. *Scutellum,* egg-yellow, with a large black marking against the anterior border. *Tegmen,* transparent, suffused with very pale green, veins colourless.

Thorax and *abdomen,* ventral surface, and *legs,* pale yellow.

Type ♀, from Parachilna, Flinders Range, South Australia, in the collection of the South Australian Museum.

Macropsis wilsoni, sp. nov.

(Plate II, fig. 10)

Length, 4 mm.

Head, width 1·5 mm., pale brownish-yellow; eyes reddish-brown; crown of head from above visible narrowly against the eyes.

Pronotum, pale brown flecked with chestnut brown. *Scutellum*, yellow. *Tegmen*, yellowish-hyaline, the anal angle suffused with dark brown.

Thorax and *abdomen*, ventral surface, and *legs*, pale brown with dark brown markings.

Type ♀, from the Grampian Mountains, Victoria (coll. F. E. Wilson), in the collection of the Australian Museum, Sydney.

Note.—A variety from Kiata is reddish-brown in colour.

Genus **Oncopsis** Burmeister

Gen. Ins. 1, 1838.

Insects in this genus can be distinguished from those in the previous genus by the character of the transverse striations on the pronotum. *Oncopsis*, like *Macropsis*, is of world-wide distribution. One species has previously been described from Australia: *balli* Kirk. (*Bull. Hawaii. Sug. Ass. Ent.* 3; p. 38, 1907).

Oncopsis scopulus, sp. nov.

(Plate II, fig. 13)

Length, 3 mm.

Head, width 1 mm., light and dark brown with dark brown punctures, the lateral arcuate markings on the frons, brown; crown from above wider against the eyes than in the centre.

Pronotum, only slightly declivous; the anterior border, medianly, and lateral angles, pale yellow; anterior half of pronotum dark brown, the posterior half dull grey, with ill-defined brown punctures. *Scutellum*, marked with a pattern of yellow and black. *Tegmen*, transparent, veins and apex of tegmen brown.

Thorax, ventral surface black. *Legs*, light and dark brown. *Abdomen*, ventral surface black, the hind border of each segment yellow; genital segments brown.

Type ♂, from Bruce Rock, Western Australia (coll. F. Drummond), in the collection of the Australian Museum, Sydney.

Oncopsis pullus, sp. nov.

(Plate II, fig. 14)

Length, 5·5 mm.

Head, width 2 mm., pale brown with dark brown punctures, the arcuate markings, and a small oval area on each side above the ocelli, ochreous; eyes dark brown; crown from above visible for its entire width, wider against the eyes than in the centre.

Pronotum, concolorous with the head, strongly declivous, so that the anterior margin is more or less at right angles to hind margin. *Scutellum,* pale yellowish-brown with dark brown punctures, the anterior lateral angles ochreous brown. *Tegmen,* transparent, suffused apically with very pale brown; veins pale brown.

Thorax, ventral surface, pale brown with dark brown markings; *Legs,* yellowish-brown, the bases of one row of spines on the hind tibiae dark-brown. *Abdomen,* ventral surface, yellowish-brown.

Type ♀, from Canberra, F.C.T. (coll. J.W.E.), in the collection of the Australian Museum, Sydney. This species has also been taken at Hobart.

Oncopsis melleus, sp. nov.

(Plate II, fig. 15)

Length, 4·8 mm.

Head, width 1·5 mm., whitish-yellow with brown maculations; arcuate markings brown, edged with black, eyes red; crown from above not visible in the centre.

Pronotum, concolorous with the head. *Scutellum,* yellowish with black punctures, anterior lateral angles black. *Tegmen,* transparent, suffused with very pale brown, the apex and the veins dark-brown.

Thorax, ventral surface, dark brown. *Legs,* pale brown with dark brown markings. *Abdomen,* ventral surface, with each segment dark brown anteriorly and pale brown posteriorly; genital segments, dark brown.

Type ♂, from Hobart, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

Oncopsis translucens, sp. nov.

(Plate II, figs. 11 a-e)

Length, 6 mm.

Head, width 1·8 mm., yellowish-white, with the arcuate markings brown, the rest of the frons dark brown; eyes pale brown; crown from above visible very narrowly in the middle, wide against the eyes.

Pronotum, declivous, with a slight median hump anteriorly; pale yellowish-white, punctate. *Scutellum,* yellow, with brown puncturations and irregular brown markings; anterior lateral angles, black. *Tegmen,* transparent, veins pale brown with white bars; appendix distinct.

Thorax, ventral surface, anteriorly pale yellowish, posteriorly black, each sclerite edged with yellow. *Legs,* light and dark brown.

Abdomen, ventral surface, pale yellowish; genital segments brown with yellow markings.

Type ♀, from Parachilna, Flinders Range, South Australia, in the collection of the South Australian Museum.

Oncopsis subfuscus, sp. nov.

(Plate II, figs. 12a, 12b)

Length, 5 mm.

Head, width 1·3 mm., whitish-yellow with dark brown punctures; eyes brown; crown from above not visible in the centre.

Pronotum, steeply declivous, the anterior border yellow; posteriorly grey with dark-brown punctures and maculations. *Scutellum*, yellow with black markings, the anterior lateral angles black. *Tegmen*, transparent, veins brown.

Thorax and *abdomen*, ventral surface, and *legs* marked with a pattern of light and dark-brown.

Type ♂, from Ooldea, South Australia (coll. A. M. Lea), in the collection of the South Australian Museum.

Oncopsis tepperi, sp. nov.

(Plate II, fig. 16)

Length, 5·2 mm.

Head, width 1·5 mm., pale reddish-brown with dark brown punctures; eyes dark brown; hind margin of head almost straight.

Pronotum, with light and dark brown markings, raised medianly into a distinct hump. *Scutellum*, yellowish-brown, the anterior lateral angles reddish-brown. *Tegmen*, brown, but for the costal margin, which is white, and the apex and clavus, which are mottled with very pale brown.

Thorax, ventral surface, dark brown. *Legs*, marked with a pattern of light and dark brown. *Abdomen*, ventral surface, pale brown.

Type ♀, from Kangaroo Island, South Australia (coll. J. G. Tepper), in the collection of the South Australian Museum.

Genus **Stenoscopus** Evans

Trans. Roy. Soc. South Australia 58; p. 166, 1934

This genus contains only one species (*drummondi* Evans), which has recently been described and figured.

Tribe AGALLIINI.

The insect described below has been compared with European and American species of *Agallia* Curtis, *Agalliopsis* Kirk., and *Aceratoagallia* Kirk., and found to differ in the shape of the head, distance between the ocelli, and dorsal thoracic segments. These differences are considered sufficiently striking to merit the erection of a new genus.

Austroagallia, gen. nov.

The head is longer than wide, and the labium reaches to between the hind legs. The ocelli, which are on the same plane as the clypeus, are sunk in depressions, and face outwards towards the eyes; they are closer to each other than to the eyes on each side. The crown is slightly produced anteriorly, and is of an even width throughout. The width of the pronotum is greater than its length, the anterior border is three-sided, and the posterior border straight. The scutellum is approximately half the length of the pronotum. The tegmina, which are steeply tectiform and have very narrow appendices, reach well beyond the end of the abdomen. The hind tibiae have four rows of long slender spines.

Austroagallia torrida, sp. nov. (Genotype)

(Plate III, figs. 1 a-e)

Length, 3·5 mm.

Head, width 1 mm., ivory with faint yellowish-brown markings; ocelli red, eyes black; crown with two large round black spots at the same distance from each other as from the eyes on each side.

Pronotum, ivory with yellowish-brown markings, and two black pear-shaped markings, lying behind those on the head. *Scutellum*, yellowish-brown. *Tegmen*, claval area, an opaque dirty-white, the rest of the tegmen transparent; veins brown, distinct.

Thorax, ventral surface, brown. *Legs*, pale yellow, the bases of larger spines brown. *Abdomen*, ventral surface, pale yellow.

Type ♂, from Adelaide, South Australia (coll. J.W.E.), in the collection of the Australian Museum, Sydney. Described from a long series of both sexes, all taken at light.

Austroagalloides, gen. nov.

In general appearance insects in this genus resemble *Idiocerus* spp. They differ, however, very widely in structure, and appear to be more closely related to *Agallia* spp., to which genus and other related genera they may be ancestral. Nothing is known of their life-history and habits beyond the fact that the majority of specimens taken have been beaten from trees of the genus *Eucalyptus*. The head lies in three distinct planes, so that the vertex bearing the ocelli and the hind margin of the frons, is more or less vertical and at right-angles to the anterior portion of the head. The ledges overhanging the antennae are pronounced, the clypeus usually extends beyond the maxillary plates, and the hind border of the frons is generally obscure. The eyes are large and prominent, so that the head, including the eyes, is wider than the pronotum at the base, and the crown from above, between the eyes, is broad and of even width throughout. The tegmina, which are long and narrow, have either a very narrow appendix or no appendix at all, and the veins have raised dots, either lying alongside them or on the veins themselves. The hind tibiae usually have an armature of weak spines, seldom set on enlarged bases. The male genitalia have large pygophores, and parameres which are half the length of the sub-genital plates.

Austroagalloides karoondae, sp. nov. (Genotype)

(Plate III, fig. 6)

Length, 7·5 mm.

Head, width 2·5 mm., pale yellowish-brown suffused with pink; eyes reddish-brown; frons convex, ocelli large, situated at the apices of the lateral margins of the frons. *Pronotum*, grey, the anterior border pale yellowish-brown; the entire pronotum covered with raised transverse black markings. *Scutellum*, pale yellowish-brown, the apex pink and the anterior lateral angles brown; anteriorly a few brown maculations. *Tegmen*, transparent, grey, dotted with raised round brown spots that do not follow the course of the veins; veins pale yellow, appendix lacking.

Thorax and *abdomen*, ventral surface, and *legs*, pale yellowish-brown suffused with pink.

Type ♀, from Murat Bay, South Australia, in the collection of the South Australian Museum. A variety from Karoonda, South Australia, has the apices of the tegmina black.

Austroagalloides rosea, sp. nov.

(Plate III, figs. 4a, 4b)

Length, 8 mm.

Head, width 2·5 mm., pale yellow, eyes dark brown.

Pronotum, parchment colour, with transverse raised black markings on the posterior two-thirds. *Scutellum*, yellowish-brown, with two median black spots and two larger black markings lying against the anterior margin. *Tegmen*, hyaline, suffused with pink; veins pink, with small raised dots lying along both sides of every vein.

Thorax and *abdomen*, ventral surface, and *legs*, pale brownish-yellow.

Type ♀, from Leura, New South Wales (coll. J.W.E.), in the collection of the Australian Museum, Sydney. A pale yellow variety of this species has been taken at Launceston, Tasmania.

Austroagalloides grisea, sp. nov.

(Plate III, figs. 5a, 5b)

Length, 7 mm.

Head, width 2·2 mm., clypeus, maxillary plates, and lorae, white; frons pinkish-yellow; the vertical portion of the vertex pink, the dorsal part, or crown, yellowish.

Pronotum, pinkish-grey, anteriorly smooth; posteriorly with raised black transverse markings. *Scutellum,* grey, smooth. *Tegmen,* hyaline, veins and hind margin bright cherry-red; costal margin colourless; veins with raised spots incorporated in them and not lying at the sides; appendix small.

Thorax and *abdomen,* ventral surface, and *legs,* pale yellowish-white.

Type ♀, from Canberra, F.C.T. (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Austroagalloides brunnea, sp. nov.

(Plate III, figs. 3a, 3b)

Length, 6·1 mm.

Head, width 2 mm., pale yellowish-brown, eyes grey. The vertex is not at right angles to the crown, and the ocelli, which are sunk in slight depressions, are visible from above. *Pronotum,* pale yellowish-brown. *Scutellum,* pale yellowish-brown, with two brown median spots and two large triangular brown markings against the anterior margin. *Tegmen,* yellowish-hyaline, veins yellow, with small raised dots on the actual veins; appendix very narrow.

Thorax and *abdomen,* ventral surface, and *legs,* pale brownish-yellow.

Type ♀, from Canberra, F.C.T. (coll. A. L. Tonnoir), in the collection of the C.S.I.R. Division of Entomology at Canberra.

Austroagalloides agalliae, sp. nov.

(Plate III, figs. 2 a-d)

Length, 5·2 mm.

Head, width 1·5 mm., biscuit colour; eyes brown, the vertex with black markings that may extend on to the frons; antennal ridges oblique; ocelli facing outwards, the eyes sunk in slight depressions.

Pronotum, pale dirty yellow, with transverse raised black markings posteriorly and an irregular pattern of small black markings behind the eyes. The anterior border of the pronotum is sunk below the level of the hind margin of the head. *Scutellum,* smooth, pale yellowish. *Tegmen,* hyaline, veins pink with raised dots.

Thorax, ventral surface, black. *Legs,* whitish with light brown markings. *Abdomen,* ventral surface black, the posterior border of each segment yellow; genital segments brown.

Type ♂, from Canberra, F.C.T. (coll. A. L. Tonnoir), in the collection of the C.S.I.R. Division of Entomology at Canberra. This species has also been taken at Adelaide, South Australia.

Austroagalloides nigra, sp. nov.

(Plate III, fig. 7)

Length, 6·1 mm.

Head, width 1·5 mm., anteriorly up to the antennal ledges, yellow; vertex and crown black; eyes reddish-brown, ocelli yellow.

Pronotum, anteriorly yellow, with black maculations, posteriorly yellow suffused with black, and with raised transverse black markings. *Scutellum*, smooth, black. *Tegmen*, yellowish-hyaline, black apically; veins black with raised dots.

Thorax and *abdomen*, ventral surface, and *legs*, yellow.

Type ♂, from Leura, New South Wales, in the collection of the Australian Museum, Sydney. A paler variety has been taken at Hobart, Tasmania.

Austroagalloides wrighti, sp. nov.

(Plate III, figs. 8a, 8b)

This species is larger and broader than the preceding ones, but in essential characters resembles other species in the genus.

Length, 7 mm.

Head, width 3·5 mm., anteriorly pale yellowish-brown, but for the frons, which is a somewhat darker brown; vertex and crown marked with an irregular pattern of yellow and black; eyes dark brown; frons swollen; ocelli facing towards the eyes; hind margin of frons distinct; eyes very prominent.

Pronotum, anteriorly brownish-yellow with irregular black markings, posteriorly grey with raised transverse black markings. *Scutellum*, rugose, marked with a pattern of light and dark brown. *Tegmen*, hyaline, with numerous cross veins and round brown spots lying alongside the main veins; appendix narrow.

Thorax and *abdomen*, ventral surface, brown. *Legs*, marked with a pattern of light and dark brown.

Type ♀, from Karoonda, South Australia (coll. G. Wright), in the collection of the South Australian Museum.

Tribe BYTHOSCOPINI

Three genera which have several common characteristics are placed together in this tribe. The head, including the eyes, is narrower than the pronotum at the base. The pronotum is wide laterally, so that the bases of the tegmina are separated from the eyes, and the propleurae which extend laterally from the pronotum are also wide. The tegmina have a somewhat narrow appendix, and the apical cubital cell serves as a supplementary appendix, the vein bounding its dorsal margin being more heavily chitinised than that bounding the tegmen within the true appendix. The hind tibiae are somewhat flattened, and bear three rows of strong spines and one row of long delicate spines. The apices of the hind femora rest just behind the eyes.

Genus **Bythoscopus** Germar

Rev. Ent. 1; p. 180, 1833.

Numerous Australian leaf-hoppers were placed in this genus by Walker. None of them is congeric with the genotype, *Bythoscopus lanio* L.

Genus **Eurinscopus** Kirkaldy

H.S.P.A. Exp. Sta. Bull. 1 (9); p. 346, 1906

Kirkaldy considered this genus to be the Australian representative of *Bythoscopus* Germ., differing from the latter in the venation of the tegmen. An examination of the paratypes of the seven species he described has shown that two of his names are synonyms. The following species were described by Kirkaldy; *lentiginosus* (genotype), *sontiates*, *soboles*, *molestia*, *dryas*, *pelias*, and *pelamys*. *E. pelias* and *E. pelamys* are synonymous with *E. dryas* Distant (1908) refused to recognize Kirkaldy's genus, and described an insect from Australia which he placed in the genus *Bythoscopus*. This species, *viridipes*, undoubtedly belongs to the genus *Eurinoscopus*.

Eurinoscopus differs from *Bythoscopus* in the absence of numerous costal cells in the tegmen, and the greater length of the tegmen in comparison with its breadth. In addition the pygophores of the male genitalia of *Eurinoscopus* do not extend ventrally so as to cover the parameres and sub-genital plates as they do in *Bythoscopus*. In spite of these differences and the fact that insects in the genus *Eurinoscopus* are smaller and slenderer than *B. lanio*, the two genera are undoubtedly very closely related. Figures (Plate IV, figs. 1a, 1b) are given of the tegmen and the head in profile of *Bythoscopus lanio*. A redescription of *Eurinoscopus* Kirk. is given below.

Head with the labium reaching to between the middle pair of legs, and the lorae anteriorly not reaching to the front margin of the maxillary plates. The frons is evenly rounded, the antennal ridges lying halfway up the lateral margins. The ocelli are large, lie well away from the frons, and are closer to the eyes on each side than to each other. The hind border of the head, as seen from below, is evenly rounded, while the crown of the head from above is of even width throughout. The eyes are not prominent, so that the head, including the eyes, is slightly narrower than the pronotum at its base. The anterior margin of the pronotum is evenly rounded and parallel to the fore (dorsal) border of the head, the lateral margins are almost parallel to each other, and the hind margin is straight. Both the head and pronotum are transversely striated. The scutellum is equal in length to the pronotum, and the apex is slightly raised. The propleurae continue laterally from the pronotum, the bases of the tegmina being widely separated from the eyes. The tegmina are long and narrow, and overlap posteriorly, the ventral apical cell forming a supplementary appendix. The veins are bordered on each side by a row of small punctures. The hind tibiae are somewhat flattened, and bear two rows of long strong spines, one row of strong short spines, and one row of delicate spines or hairs. The male genitalia resemble those of *Austroagalloides* in the development of the pygophores, and such genera as *Macropsis* in the possession of long and narrow parameres and sub-genital plates.

Eurinoscopus viridis, sp. nov.

(Plate IV, fig. 5)

Length, 5 mm.

Head, width 1·5 mm., emerald green, but for the frons and ocelli, which are yellowish; eyes dark brown.

Pronotum, emerald green. *Scutellum*, emerald green, lateral angles and apex yellow. *Tegmen*, transparent, suffused with pale yellowish-green.

Thorax and *abdomen*, ventral surface, and *legs*, pale yellowish-green.

Type ♂, from Adelaide, South Australia (coll. J.W.E.), in the collection of the Australian Museum, Sydney. A variety from Canberra is pale brownish-yellow in colour and has red eyes.

Eurinoscopus pallidus, sp. nov.

(Plate IV, figs. 3a, 3b)

Length, 4·5 mm.

Head, width 1·8 mm., pale brownish-yellow.

Pronotum and *scutellum*, pale brownish-yellow.

Thorax and *abdomen*, ventral surface, and *legs*, very pale brownish-yellow.

Type ♀, from Hobart, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

Eurinoscopus elegans, sp. nov.

(Plate IV, figs. 2 a.-b)

Length, 5·5 mm.

Head, width, 1·8 mm., pale chestnut brown, dark brown between the ocelli; ocelli colourless, eyes pale chocolate-brown.

Pronotum, pale brownish-yellow, with orange-brown markings. *Scutellum*, brownish-yellow, the anterior lateral angles orange-brown. *Tegmen*, hyaline, yellowish-green.

Thorax and *abdomen*, ventral surface, pale brownish-yellow. *Legs*, brown.

Type ♂, from Hobart, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

Eurinoscopus citrinus, sp. nov.

(Plate IV, fig. 4)

Length, 6·2 mm.

Head, width 1·8 mm., pale lemon-yellow, dorsal margin of frons above antennal ledges distinct.

Pronotum and *scutellum*, pale lemon-yellow. *Tegmen*, yellowish-hyaline, rugose, with a few brown spots on the veins and no cross veins.

Thorax and *abdomen*, ventral surface, and *legs*, pale lemon-yellow.

Type ♀, from Canberra, F.C.T. (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Chinaella, gen. nov.

The head is evenly rounded, the antennal ledges are prominent, the hind margin of the frons is distinct, and the ocelli are on the ventral surface of the head. The crown is visible narrowly from above, being widest against the eyes, and the head, including the eyes, is narrower than the pronotum at the base. The lateral margins of the pronotum are narrow in comparison with species in related genera, but sufficiently wide to separate the bases of the tegmina from the eyes, and the propleurae are visible as lateral prolongations of the pronotum. The tegmina overlap very considerably, so that when the tegmina are closed the distal parts of the anal borders lie at an acute angle to the proximal conjoined borders. The appendix is wide, and there is a supplementary appendix. Insects in this genus, whilst resembling *Eurinoscopus* spp. in the shape of the head and the position of the ocelli, are more similar in general appearance to *Trocnada* spp.

Chinaella argentata, sp. nov. (Genotype)

(Plate IV, fig. 6)

Length, 4·5 mm.

Head, width 2 mm., cream colour mottled with pale reddish-brown.

Pronotum, steeply declivous, golden-yellow flecked with brown. *Scutellum,* reddish-yellow. *Tegmen,* proximally brownish-yellow, distally yellowish-white; veins brown, venation reticulate.

Thorax, ventral surface, and *legs,* pale brown. *Abdomen,* ventral surface, white suffused with very pale brown; genital segments brown.

Type ♀, from the Everard Ranges, South Australia (coll. A. Brumby), in the collection of the South Australian Museum.

Chinaella shephardi, sp. nov.

Length, 4 mm.

Head, width 1·8 mm., frons and vertex reddish-brown mottled with yellow, clypeus, lorae, and maxillary plates black; eyes grey.

Pronotum, reddish-brown, slightly declivous. *Scutellum,* yellowish-brown with dark brown markings. *Tegmen,* reddish-brown with a white streak along the costal margin and a purplish-brown stripe lying along the claval suture; veins brown apically.

Thorax, ventral surface, and *legs,* dark brown. *Abdomen,* ventral surface, pale brown.

Type ♀, from Broken Hill, New South Wales (coll. F. W. Shephard), in the collection of the South Australian Museum.

sp. nov.

Chinaella cudmorei, sp. nov.

(Plate IV, fig. 7)

Length, 4 mm.

Head, width 1·5 mm., anteriorly and frons, ochreous; vertex, pale brownish-yellow.

Pronotum, ochreous. *Scutellum,* dark reddish-brown, apically pale brown. *Tegmen,* hyaline, mottled with pale brown; veins pale brown, venation not reticulate.

Thorax and *abdomen,* ventral surface, and *legs,* pale brown.

Type ♂, from 130 miles S.E. of Broome, Western Australia (coll. A. S. Cudmore), in the collection of the Australian Museum, Sydney.

Genus **Trocnada** Walker

Ins. Saund. Homopt. 104, 1858

The head lies in two distinct planes of approximately equal length, the anterior portion up to the antennal ledges is parallel to the long axis of the body, and the posterior portion, on which is situated the hind margin of the frons and the ocelli, is vertical and at right-angles to the axis of the body. The antennal ledges are curved, and project beyond the surface of the head. The pronotum, which is transversely striated, is very steeply declivous, and at the base is wider than the head. It is wide laterally, and the propleurae are visible, and separate the eyes from the bases of the tegmina. The tegmina have, in addition to a wide appendix, a supplementary appendix formed from the apical cubital cell; this cell is not pigmented. The apices of the hind femora rest just behind the eyes, and the hind tibiae, which are somewhat flattened, bear four rows of spines.

One species has previously been placed in this genus, *Trocnada dorsigera* Walker. *Albelterus incarnatus* Stål (*Öfv. Vet-Ak. Forh.* 22; p. 1, 1865) is synonymous with *T. dorsigera*.

Trocnada gigantea, sp. nov.

(Plate IV, figs. 8a, 8b)

Length, 8·2 mm.

Head, width 3 mm., pale biscuit colour suffused with pink; ocelli colourless or red, eyes red.

Pronotum, pale biscuit colour, in some specimens suffused with pink. *Scutellum*, yellowish-pink. *Tegmen*, pink.

Thorax, ventral surface, and *legs*, biscuit colour partly suffused with pink. *Abdomen*, ventral surface, pale biscuit colour.

Type ♀, from Karoonda, South Australia, in the collection of the South Australian Museum.

Trocnada minuta, sp. nov.

(Plate IV, fig. 9)

Length, 4·5 mm.

Head, width 1·8 mm., ochreous, ocelli pink.

Pronotum, reddish-brown. *Scutellum*, dark brown. *Tegmen*, hyaline brown, veins pinkish-brown.

Thorax and *abdomen*, ventral surface, and *legs*, ochreous brown.

Type ♂, from Canberra, F.C.T. (coll. J.W.E.), in the collection of the C.S.I.R. Division of Entomology at Canberra.

Tribe IDIOCERINI

This tribe contains two Australian genera. Of these, *Idiocerus* Lewis is of world-wide distribution, whilst *Pedioscopus* Kirk. is confined to Australia. Insects in these genera resemble *Austroagalloides* spp. in general appearance, but differ in the shape of the head, the venation of the tegmina, the presence of a broad appendix, the armature of the hind tibiae, and the structure of the male genitalia.

Genus **Idiocerus** Lewis

Trans. Ent. Soc. London 1; p. 47, 1835

Fourteen species have previously been described from Australia: *cupreus* Walk. (*Bythoscopus*), (List Homopt. 111; 871, 1851); *ipo* Kirk. (*Bull. Hawaii. Sug. Ass. Ent.* 1 (9); 466, 1906), and *kisseis* Kirk., *oreias* Kirk., *orodemnias* Kirk., *zantho* Kirk., *hyleorais* Kirk., *cupido* Kirk., *napais* Kirk., *aulonias* Kirk., and *nereias* Kirk., (*H.S.P.A. Bull.* 3; pp. 32-4, 1907); *geoffroyi* Dist. (*Ann. Soc. Ent. Belg.* 52; 99, 1908); *leurensis* Evans (*Trans. Roy. Soc. South Austr.* 58; p. 167, 1934).

A redescription of this genus has been published recently, so it will be sufficient to give here such characters as will serve to distinguish it from other genera described in this paper.

The head is slightly convex, and the ocelli lie more or less on the same plane as the clypeus. The dorsal margin of the frons is not distinct, and the ocelli appear to lie at the apices of the lateral margins of the frons. The eyes are large, and the crown of the head from above is broad and of equal breadth throughout, and the head, including the eyes, is wider than the pronotum at its base. The tegmina have very broad appendices, and there are never more than two sub-apical cells between the radius and the cubitus. The subgenital plates of the male are usually long and narrow and the parameres short.

Idiocerus kirkaldyi, sp. nov.

(Plate IV, figs. 9b, 10b)

Length, 6·8 mm.

Head, width 2 mm., yellow suffused with pink, with two round black markings on the vertex close to the eyes; eyes chocolate-brown; clypeus wider anteriorly than at the base, frons almost flat.

Pronotum, yellow suffused with pink, with two black markings behind the eyes and close to the posterior border. *Scutellum*, marked with a pattern of black and pinkish-yellow. *Tegmen*, transparent, grey apically; veins pink, costal margin black.

Thorax and *abdomen*, ventral surface, pale yellow. *Legs*, marked with a pattern of pink, yellow, and brown.

Type ♀, from Leura, New South Wales (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

*

Idiocerus seckeri, sp. nov.

Length, 5·5 mm.

Head, width 2 mm., pale pinkish-yellow.

Pronotum, concolorous with the head. *Scutellum*, pinkish-brown. *Tegmen*, brown, hyaline, with two transparent white fasciae; costal margin between the fasciae, reddish-brown; veins pink.

Thorax, ventral surface, white with black markings. *Legs*, very pale yellow. *Abdomen*, ventral surface, black, each segment white posteriorly.

Type ♂, from Lucindale, South Australia (coll. F. Secker), in the collection of the South Australian Museum.

Idiocerus inconsequens, sp. nov.

Length, 4·5 mm.

Head, width 1·2 mm., yellowish-green, eyes dark-brown, frons flat.

Pronotum and *scutellum*, yellowish-green. *Tegmen*, hyaline, yellowish-green.

Thorax and *abdomen*, ventral surface, and *legs*, yellowish-green; abdomen not nearly reaching posteriorly to the apex of the folded tegmina.

Type ♀, from Emerald, Victoria (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Idiocerus divisus, sp. nov.

(Plate IV, fig. 19)

Length, 4 mm.

Head, width 1·2 mm., yellowish-pink, eyes dark brown, frons swollen.

Pronotum and *scutellum*, yellowish-pink. *Tegmen*, hyaline, yellowish-pink.

Thorax and *abdomen*, ventral surface, and *legs*, yellowish-pink; posterior margin of the last ventral abdominal segment in the female divided medianly.

Type ♀, from Bruce Rock, Western Australia (coll. F. Drummond), in the collection of the Australian Museum, Sydney.

Idiocerus lesmurdiensis, sp. nov.

Length, 3 mm.

Head, width 1 mm., bright yellow, with a large oval pink area on the vertex.

Pronotum and *scutellum*, yellow. *Tegmen*, transparent, suffused with pale green; proximal costal margin white.

Thorax and *abdomen*, ventral surface, and *legs*, yellow; posterior margin of the last ventral abdominal segment in the female, straight; apex of abdomen nearly reaching to the tip of the folded tegmina.

Type ♀, from Lesmurdie, Western Australia (coll. F. Drummond), in the collection of the Australian Museum, Sydney.

Genus **Pedioscopus** Kirkaldy

H.S.P.A. Exp. Sta. Bull. 1 (9) ; p. 349, 1906

This genus, which comprises insects closely allied to *Idiocerus*, is apparently confined to Australia. The figures of *P. polydoros* Kirk. (Plate IV, 12, 12a, 12b) were drawn from the paratype. The venation is unusual, the median vein being distinct, and not fused basally with the radius. Kirkaldy described the following species: *philenor*, *polydoros*, and *agenor*. *P. agenor* is a synonym of *P. polydoros*.

CONCLUSION

It is hoped that when this series of papers is completed it will be possible to present a summary, giving a key to the families, subfamilies, tribes, and genera dealt with, and at the same time to indicate the various evolutionary trends within the groups concerned. The present need is more material for study, since leaf-hoppers are usually passed over by collectors, and the material now available in Australian museums can represent only a very small proportion of the available fauna. Kirkaldy (1906), in commenting on the rich fauna of leaf-hoppers that must occur in Australia, pointed out that Koebele and Perkins collected for only a few months in the very places that an entomologist, not collecting for an economic purpose, would avoid on account of their barrenness. Yet their efforts produced nearly five hundred new species. The collection named by Kirkaldy was taken almost entirely in Queensland and the coastal districts of New South Wales. The bulk of the material that has been available to the present author was collected on the mountains and tablelands of New South Wales and in South Australia. The most interesting Jassoid fauna occurs in Western Australia, a region in which systematic collecting has never been undertaken.

ACKNOWLEDGEMENTS.

The systematist who is out of touch with libraries and museums is to a great extent dependent on those more fortunately placed if he is to make any real progress, and not merely to add to the confusion already existing. In this study of the Australian Jassoidea, I have been in constant correspondence with Mr. W. E. China, of the British Museum, who has never failed to assist me, and without whose aid this series of papers could never have been written. I am also indebted to Dr. O. H. Swezey, of Honolulu, for the loan of seventy-four of Kirkaldy's paratypes; to Professor H. B. Hungerford, for the gift of a large collection of named American Jassoidea, which have been invaluable for comparative purposes; and to the authorities in charge of the South Australian Museum, for permitting me to examine the collection in their care.

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EXPLANATION OF PLATES

PLATE II—

Fig. 1a.—*Macropsis victoriensis*, head, ventral aspect.
Fig. 1b.—*Macropsis victoriensis*, head and thorax, dorsal aspect.
Fig. 1c.—*Macropsis victoriensis*, tegmen.
Fig. 2.—*Macropsis occidentalis*, head and thorax, dorsal aspect.
Fig. 3.—*Macropsis federalis*, head and thorax, dorsal aspect.
Fig. 4.—*Macropsis filicis*, head and thorax, dorsal aspect.
Fig. 5.—*Macropsis tasmaniensis*, head and thorax, dorsal aspect.
Fig. 6.—*Macropsis luteus*, head and thorax, dorsal aspect.
Fig. 7.—*Macropsis hobartensis*, head and thorax, dorsal aspect.
Fig. 8.—*Macropsis lincolnensis*, head and thorax, dorsal aspect.
Fig. 9.—*Macropsis flindersi*, head and thorax, dorsal aspect.
Fig. 10.—*Macropsis wilsoni*, head and thorax, dorsal aspect.
Fig. 11a.—*Oncopsis translucens*.
Fig. 11b.—*Oncopsis translucens*, head, ventral aspect.
Fig. 11c.—*Oncopsis translucens*, head and thorax, dorsal aspect.
Fig. 11d.—*Oncopsis translucens*, tegmen.
Fig. 11e.—*Oncopsis translucens*, hind tibia.
Fig. 12a.—*Oncopsis subfuscus*, tegmen.
Fig. 12b.—*Oncopsis subfuscus*, head and thorax, dorsal aspect.
Fig. 13.—*Oncopsis scopulus*, head and thorax, dorsal aspect.
Fig. 14.—*Oncopsis pullus*, head and thorax, dorsal aspect.
Fig. 15.—*Oncopsis melleus*, head and thorax, dorsal aspect.
Fig. 16.—*Oncopsis tepperi*, head and thorax in profile.

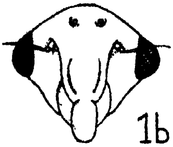
PLATE III—

Fig. 1a.—*Austroagallia torrida*, tegmen.
Fig. 1b.—*Austroagallia torrida*, head, ventral aspect.
Fig. 1c.—*Austroagallia torrida*, head and thorax, dorsal aspect.
Fig. 1d.—*Austroagallia torrida*, hind tibia.
Fig. 1e.—*Austroagallia torrida*, male genitalia.
Fig. 2a.—*Austroagalloides agalliae*, tegmen.
Fig. 2b.—*Austroagalloides agalliae*, head, ventral aspect.
Fig. 2c.—*Austroagalloides agalliae*, head and pronotum, dorsal aspect.
Fig. 2d.—*Austroagalloides agalliae*, male genitalia.
Fig. 3a.—*Austroagalloides brunnea*, head, ventral aspect.
Fig. 3b.—*Austroagalloides brunnea*, head and pronotum, dorsal aspect.
Fig. 4a.—*Austroagalloides rosea*, tegmen.
Fig. 4b.—*Austroagalloides rosea*, head and pronotum, dorsal aspect.
Fig. 5a.—*Austroagalloides grisea*, head and pronotum, dorsal aspect.
Fig. 5b.—*Austroagalloides grisea*, hind tibia.
Fig. 6.—*Austroagalloides karoondae*, head and pronotum, dorsal aspect.
Fig. 7.—*Austroagalloides nigra*, head and pronotum, dorsal aspect.
Fig. 8a.—*Austroagalloides wrighti*, dorsal aspect.
Fig. 8b.—*Austroagalloides wrighti*, ventral aspect.

PLATE IV—

Fig. 1a.—*Bythoscopus lanio*, tegmen.
Fig. 1b.—*Bythoscopus lanio*, head in profile.
Fig. 2a.—*Eurinoscopus elegans*.

Fig. 2b.—*Eurinoscopus elegans*, tegmen.
Fig. 2c.—*Eurinoscopus elegans*, head and thorax in profile.
Fig. 2d.—*Eurinoscopus elegans*, head, ventral aspect.
Fig. 2e.—*Eurinoscopus elegans*, head and thorax, dorsal aspect.
Fig. 2f.—*Eurinoscopus elegans*, male genitalia.
Fig. 3a.—*Eurinoscopus pallidus*, head and thorax, dorsal aspect.
Fig. 3b.—*Eurinoscopus pallidus*, hind leg.
Fig. 4.—*Eurinoscopus citrinus*, head and thorax, dorsal aspect.
Fig. 5.—*Eurinoscopus viridis*, head and thorax, dorsal aspect.
Fig. 6.—*Chinaella argentata*.
Fig. 7.—*Chinaella cudmorei*, male genitalia.
Fig. 8a.—*Trocnada gigantea*, head and thorax in profile.
Fig. 8b.—*Trocnada gigantea*, hind tibia.
Fig. 9.—*Trocnada minuta*, head and pronotum, anterior aspect.
Fig. 9b.—*Idiocerus kirkaldyi*.
Fig. 10b.—*Idiocerus kirkaldyi*, hind tibia.
Fig. 11.—*Idiocerus divisus*, head, ventral aspect.
Fig. 12.—*Pedioscopus polydoros*, head, ventral aspect.
Fig. 12a.—*Pedioscopus polydoros*.
Fig. 12b.—*Pedioscopus polydoros*, tegmen.



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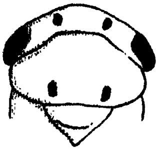

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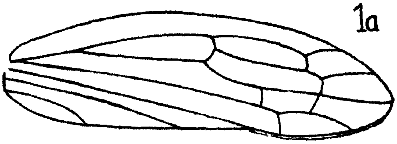

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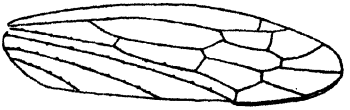

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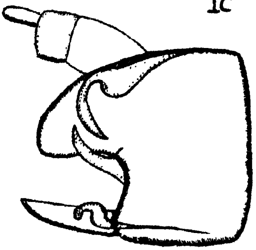

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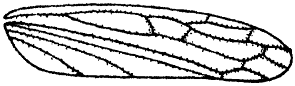

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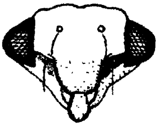

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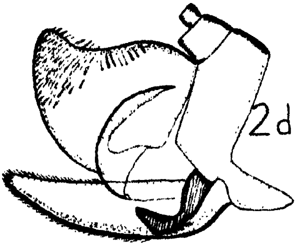

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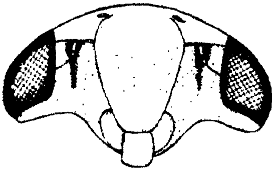

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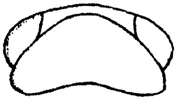

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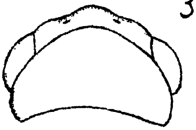

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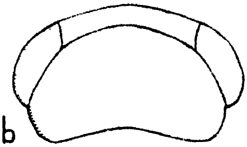

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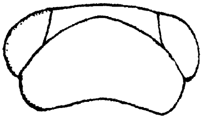

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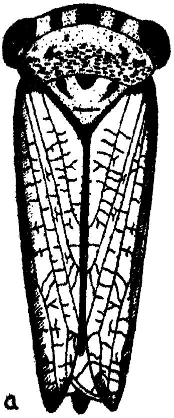

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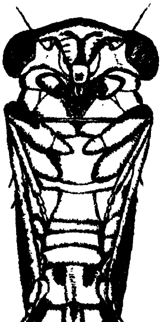

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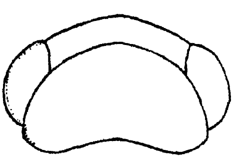

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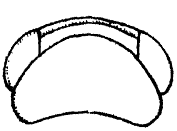

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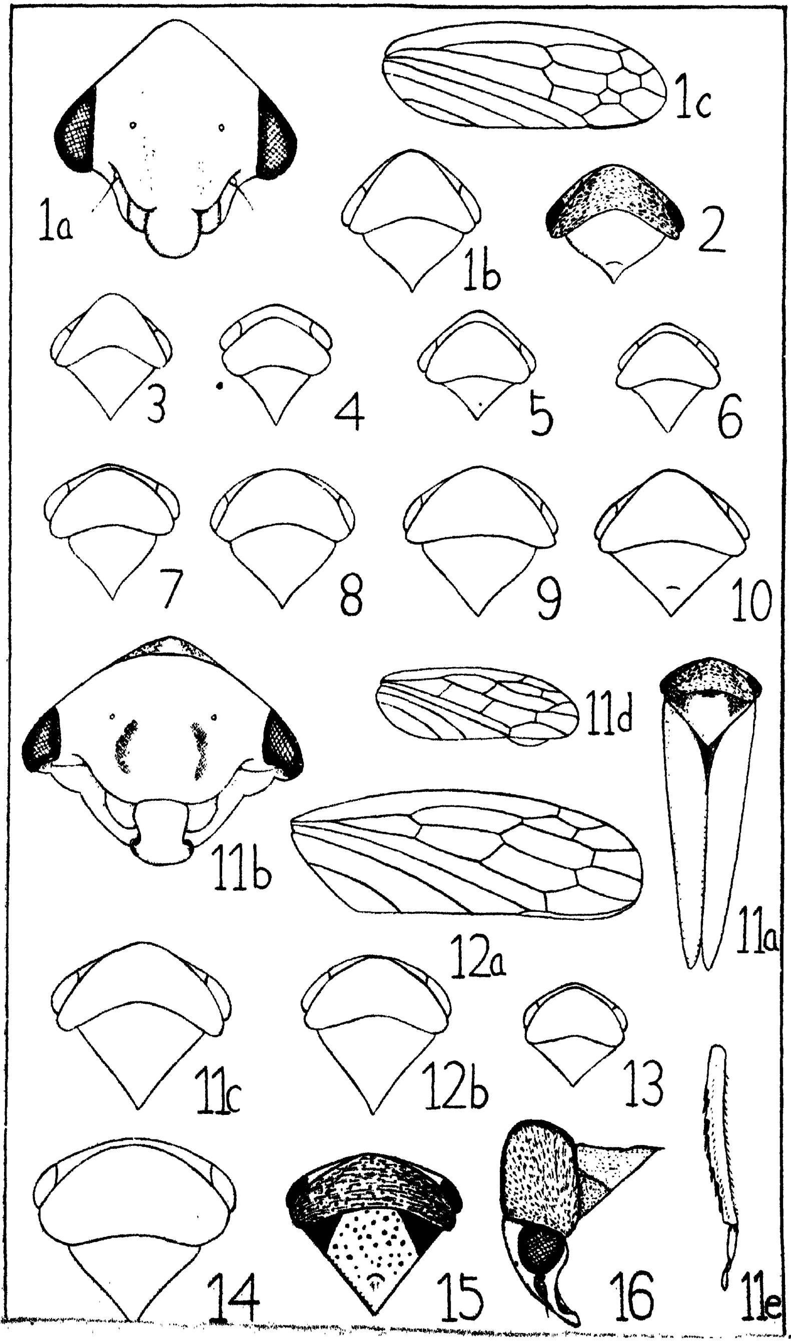
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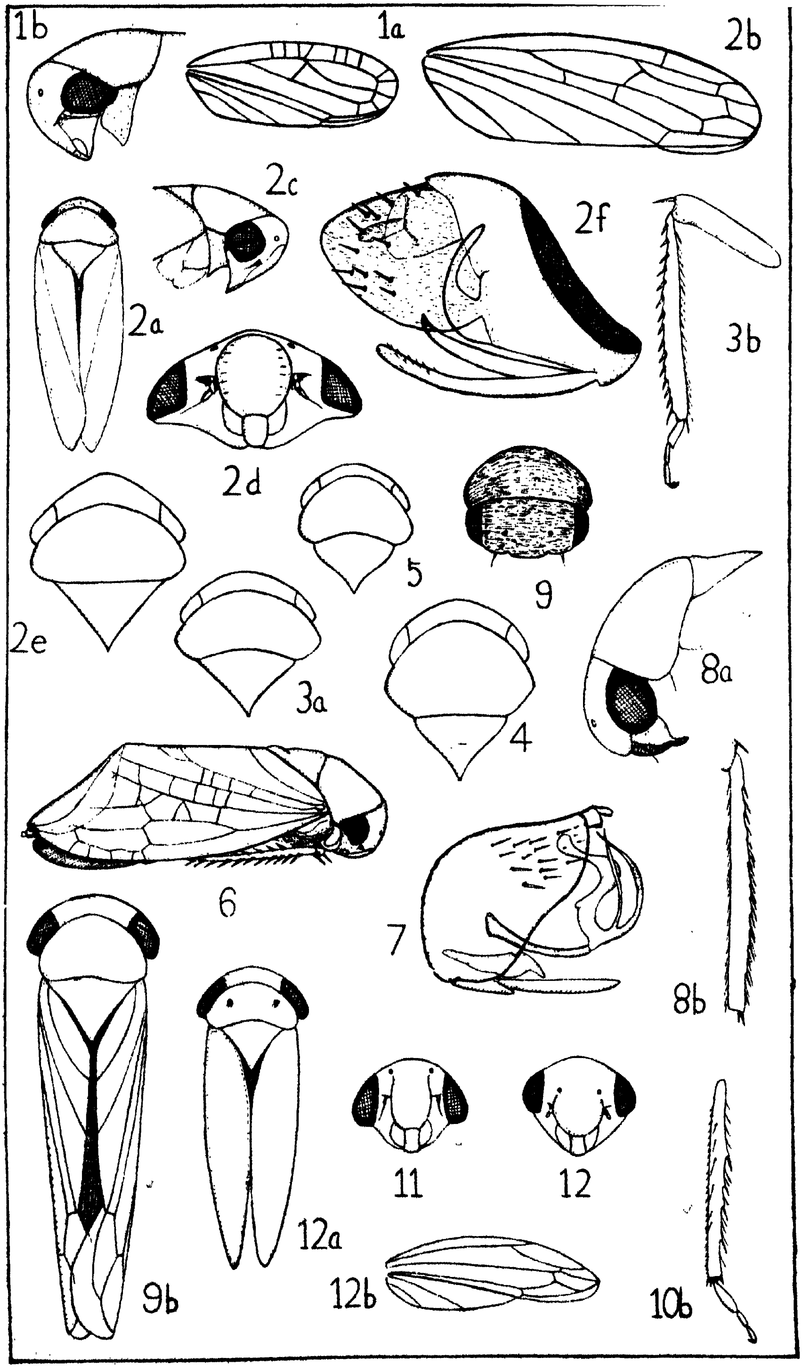
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Observations on Fishes of the Family Galaxiidae

Part I

By

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(Read 30th September, 1935)

In addition to their general importance as members of a remarkable family, the Tasmanian Galaxiidae are of special interest for several reasons. First, there are, as shown below, good grounds for believing that the island provides the type-locality of the genotype of the foundation-genus; secondly, the early observations of Johnston in Tasmania rank in historic interest with those of Hutton and Clarke in New Zealand; thirdly, the diversity of the Tasmanian Galaxiid fauna, it is now becoming apparent, rivals that of New Zealand, traditionally regarded as the headquarters of the family.

The primary object of the present paper is the description of four new species, one of which is referred to a new genus, *Saxilaga*, an interesting annectant form linking *Galaxias* Cuvier and *Neochanna* Günther.

Previously described Tasmanian species are listed, and in several cases commented upon: a detailed consideration of them is reserved, however, for a subsequent communication.

Since the revision by Regan, some thirty years ago, the family has considerably increased in number and diversity of forms, and it is apparent the time has arrived when some redistribution of its members is called for. In a recent paper Whitley (1935) has expressed the opinion that *Galaxias indicus* Day,[1] from littoral districts of Bengal and Madras, is 'only superficially like a *Galaxias*, and belongs to some other genus not yet determined', and has suggested the new generic names *Nesogalaxias*, *Lyragalaxias*, and *Querigalaxias*, for *Galaxias neocaledonicus* Weber and De Beaufort (New Caledonia), *Galaxias o'connori* Ogilby (Queensland), and *Galaxias dissimilis* Regan (? New South Wales), respectively. As these proposed names are not yet validated by the provision, in accordance with the Code, of a summary of characters, it seems advisable, in order both not to anticipate Mr. Whitley's conclusions and to avoid any possibility of nomenclatural confusion. to leave the species concerned for the present in the position in which they now stand. *Galaxias bullocki* Regan, for which the genus *Brachygalaxias* has been proposed, I would at present be inclined to refer to a subgenus of *Galaxias*, occupying the position tentatively shown in brackets in the accompanying key, rather than to a separate genus: it is possible, however, that the two main characters noted by Regan (1908) as distinguishing it from all other species, namely, the presence of only five rays in the pelvic, and the insertion of the anal partly in advance of the dorsal, may prove, upon further consideration, to be worthy, when regarded in combination, of generic recognition. The resuscitation by Whitley of Ogilby's genus *Austrocobitis* for *Galaxias attenuatus* (Jenyns) has not been followed here, again in view of the absence of the diagnosis needed for the satisfactory delimitation of the genus.

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[1] **This species, which is not noted by Regan (1906) in his revision, is described (1888, p. 806) as having 'fine conical' teeth 'in the lower jaw, vomer and palatines, and some larger ones on the tongue'; the pelvics are eight-rayed.**

The suggestions in regard to classification put forward in the present communication are governed by the desire, first, to supply such elements of the scaffolding of the taxonomic frame of reference as seem at once well-founded and expedient for the convenient handling of the material here dealt with, and, secondly, to avoid taking, at the present stage of the inquiry, any steps likely in any way to prejudice the complete revision of the systematics of the family that is undoubtedly desirable, but for which adequate data are perhaps not yet available.

The present taxonomic proposals comprise the institution of two new subfamilies, a new genus, with two subgenera, and two new subgenera of *Galaxias*. The primary feature on which the subfamilies are based is the general location of the dorsal, whether above the anal or the pelvic; to which may be added in part the uniserial or biserial arrangement of the premaxillary and mandibulary teeth, and the number of vertebrae. Characters regarded as of generic importance are the presence or absence of teeth on the palate, and the presence or absence of pelvic fins; while the number of rays in the pelvic is accorded subgeneric recognition. In the forms with a posteriorly placed dorsal the exact point of origin of the fin in relation to the anal, while affording a superficially attractive, if confessedly somewhat artificial, subgeneric criterion, is not made use of here for, among others, the following reasons: first, it exhibits some individual variation; secondly, its employment would involve, on the one hand, the association of species (*e.g.*, *G. (G.) attenuatus* and *G. (G.) scopus*) that, judged by other standards, are obviously far from being closely allied, and, on the other hand, the separation of species (*e.g.*, *G. (G.) auratus* and *G. (G.) scopus*) clearly belonging to the same group.

In retaining *Paragalaxias shannonensis* (and possibly also *G. dissimilis* Regan) in the Galaxiidae a conservative course has been followed. It may be observed that Regan (1913, p. 289) has pointed out, and has since (1914, p. 405) emphasized the importance of, the fact that of the salmonoid fishes, *sensu lato*, the Salmonidae alone have the vertebrae upturned at the base of the caudal fin. A comparison of *P. shannonensis* (all examples of which hitherto secured are small, the largest, the holotype, having a total length of 40·7 mm.), *G. attenuatus*, and *Salmo irideus* Gibbons seems to show that, morphologically, no sharp line of demarcation can be drawn between them. The practical value of the criterion, which lies principally in the circumstance that the upturned centra in the representative of the Salmonidæ are more or less of normal form, would appear to be considerably diminished by the rather distinctly marked segmentation of the upwardly deflected section, accompanied by no great attenuation of the centra, met with in *P. shannonensis*, and by the existence, though to a less marked degree, of an essentially similar state of affairs in young individuals of *G. attenuatus*. It is of interest to observe, incidentally, that in immediately post-larval examples of the lastnamed species the upward flexure of the distal end of the vertebral axis is clearly indicated during life by the course of a line of dark pigment deposited along the superior border of the notochordal sheath.

KEY TO SUBFAMILIES, GENERA, AND SUBGENERA OF GALAXIIDAE HERE CONSIDERED

A. Dorsal fin inserted well back (about over anal fin); teeth in the jaws uniserial, vertebrae > 50	Subfamily *GALAXIINAE*
B. Teeth present on entopterygoids; dorsal and anal fins relatively high	Genus *Galaxias*
C. Pelvic fin with seven rays	Subgenus *Galaxias*
CC. Pelvic fin with six rays	Subgenus *Agalaxis*
[CCC. Pelvic fin with five rays	*Galaxias bullocki* Regan]
BB. No teeth on entopterygoids: dorsal and anal fins relatively low:	
D. Pelvic fins present	Genus *Saxilaga*
E. Pelvic fin with six rays; lingual teeth biserial	Subgenus *Saxilaga*
EE. Pelvic fin with five rays; lingual teeth in more than two series	Subgenus *Lixagasa*
[DD. Pelvic fins absent	
F. Anal and dorsal fins subcontinuous with caudal fin	Genus *Neochanna*]
AA. Dorsal fin inserted well forward (about over pelvic fin); teeth in the jaws biserial or uniserial; [vertebrae < 50 in *P. shannonensis*]	Subfamily *PARAGALAXIINAE*
G. Teeth in the jaws biserial	Genus *Paragalaxias*
[GG. Teeth in the jaws uniserial	*Galaxias dissimilis* Regan]

Family GALAXIIDAE

Subfamily *GALAXIINAE*, nov.

Diagnosis. Dorsal fin inserted well back, about over anal fin, the length to origin of dorsal being about two-thirds of total length. Pelvic fins present or absent. Premaxillary and mandibulary teeth uniserial. Entopterygoids toothed or toothless. Lingual teeth in two or more series. Vertebrae more than 50.

Type-genus. Galaxias Cuvier, 1817.

The subfamily includes *Galaxias* Cuvier, *Neochanna* Günther, and *Saxilaga*, nov.

Genus **Galaxias** Cuvier, 1817

Galaxias Cuvier, *Règn. Anim.* ed. 1. II. 1817. p. 183.[1]
Mesites Jenyns, *Zool. Voy. Beagle.* III. *Fish.* 1842. p. 118. Preoccupied by ***Mesites*** Geoffroy, 1838 (Aves), and ***Mesites*** Schoenherr, 1838 (Coleoptera).
Austrocobitis Ogilby, *Proc. Linn. Soc. N.S.W.* XXIV. 1899. p. 158. Substitute for ***Mesites*** Jenyns, preoccupied.

Diagnosis. Body more or less elongate. Dorsal fin inserted well back; free of caudal; relatively high; with 9-15 rays, which are mixed (simple and branched). Anal fin partly below dorsal; free of caudal; relatively high; with 10-19 mixed rays. Pelvic fins present; with 7, 6, or 5 rays. Premaxillary and mandibulary teeth uniserial, conical, pointed. Entopterygoids each with a single series of teeth. Lingual teeth biserial. Eye fairly large to small; with free circular lid. Vertebrae 53-64, *fide* Regan (1906, p. 365).

Haplotype. Esox truttaceus Cuvier.

Subgenus **Galaxias,** nov.

Diagnosis. Pelvic fin with 7 rays.

Orthotype. Esox truttaceus Cuvier = *Galaxias (Galaxias) truttaceus* (Cuvier).

This, the typical and dominant section of the family, includes 24 of the 27 species of *Galaxias* regarded by Regan in his revision as well established, a total since considerably extended. McCulloch (1929) admitted 18 Australian species, including the 5 species accredited by authors generally to Tasmania, to which 3 species are here added. Phillipps (1926 (a)) listed 8, and later (1927) 7 New Zealand species, and Regan (1913) noted 6 species from South American localities, referable to this subgenus.

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[1] McCulloch (1929, p. 47), citing this reference, gives the date as ' " 1817 " = Dec. 1816 ', and adopts 1816 as the date of publication of the genus. Sherborn, however, in his bibliography (*Index. Anim.* 1801-1850. I. 1922. p. xli) seems clearly to indicate that only vol. 1 of the first, or " 1817 ", edition was published in Dec., 1816, and in his systematic text (XI. 1926. p. 2621) formally gives 1817 as the date for *Galaxias* Cuvier. Sherborn has questioned the validity of this edition, noting ' it abounds in vernaculars ' : and has observed that ' Cuvier's vernac. are latinized and available for first time by Schinz ', *i.e.*, *Das Thierreich.* 4 vols. Stuttgart. 1821-1825 (vol. 2, with *Galaxias*, 1822).

Distribution. Australia, and neighbouring islands; Tasmania, and neighbouring islands; New Zealand and neighbouring, and sub-antarctic, islands; Falkland Islands; Tierra del Fuego; Patagonia, and neighbouring islands; Argentina; Chile; &c.: not South Africa. [*G. neocaledonicus* Weber and De Beaufort, which, if retained in *Galaxias*, would be, to judge from the original account in the *Zoologischer Anzeiger*, XLII, 1913, p. 173, referable to this subgenus, is from Southern New Caledonia.]

Galaxias (Galaxias) truttaceus (Cuvier)

Esox truttaceus Cuvier, *Règn. Anim.* ed. 1. II. 1817. p. 184.
Galaxias ocellatus McCoy, *Intercol. Exhib. Essays.* 7. 1866. p. 14.

Distribution. Tasmania, and neighbouring islands; Victoria: not New Zealand. Type-locality (by present designation): Agnes River, South-Eastern Tasmania.

In the Check-List McCulloch (1929, p. 48) gives the original reference to this species as—'1816. *Esox truttaceus* Cuvier, *Règn. Anim.*, ed. 1, II, "1817" = Dec. 1816, p. 184; ed. 2, II, 1829, p. 283. *Ex Esox alepidotus* Forster MS. No locality [= New Zealand].'

Realizing that an error had somehow crept in, apparently arising from some confusion regarding *Esox alepidotus* Forster MS., and believing that the type-locality should certainly be Tasmania, I have communicated with Mr. G. P. Whitley, Ichthyologist, Australian Museum, Sydney, who agrees with me that the designation of New Zealand is incorrect, and has very kindly supplied the greater part of the bibliographical data discussed below.

Disregarding the interesting side-issues that arise in connexion with the status of *E. argenteus* Gmelin, *E. argenteus* Forster MS., *E. alepidotus* Forster, and *G. forsteri* Cuvier and Valenciennes, the position in regard to *G. truttaceus* may be summarized as follows. (*a*) In the first edition of Cuvier (1817, pp. 183-184) we find the first publication of the names *Galaxias* and *Esox truttaceus*—*i.e.*, the generic and specific names of the present form, the former in the heading (p. 183) to the description, 'Les Galaxies. (Galaxias. Cuv.)', the latter in a footnote (p. 184), '*Esox truttaceus* Cuv. espèce nouvelle, ou peut-être l' *es. argenteus* Forster?' (*b*) Here, it is to be noted, no locality is given, nor is there any mention of *Esox alepidotus* Forster as such. (*c*) Mr. Whitley remarks that at that date the French had little knowledge and very few specimens of New Zealand fauna, and surmises that Forster's MS. description of *alepidotus* was probably in Berlin. (*d*) In the second edition of Cuvier (1829, p. 283) the description of the genus is the same as that in the first, but the footnote reads, '*Esox truttaceus* Cuv.;—*Esox alepidotus* Forst.', indicating that Cuvier considered these two (separate) species belonged to *Galaxias*: no localities are given. This account is translated as it stands by Voigt (1829). (*e*) In the German edition of Cuvier by Schinz (1822, p. 309), a translation and enlargement of the first edition, in which Cuvier's names are latinized, the combination *Galax (ias) truttaceus* appears for the first time. (*f*) In the second (the only accessible) edition of Cuvier and Valenciennes (1846, p. 253) appears the following passage. ' Le genre Galaxie est une création de M. Cuvier; il l'a établi sur un petit poisson, rapporté de la Nouvelle-Holland par MM. Péron et Lesueur, et qui a été ensuite retrouvé par MM. Quoy et Gaimard. Ces deux chirurgiens de la marine royale nous apprirent que le poisson de Péron vivait dans les eaux douces de la terre de Van-Diemen '. (*g*) These facts, particularly (*f*), seem clearly to show that the type-locality of New Zealand, given by McCulloch, is erroneous, and further, that it should be ' fresh water, Tasmania '. There seems to me little doubt that the type-material of the species was collected in the D'Entrecasteaux Channel district during the visit of Baudin's expedition, January 13th - February 17th, 1802. This would presumably be now in the Paris Museum. Dealing with an excursion made by a party in the neighbourhood of the ' Rivière Fleurieu ' inland from ' le port des Cygnes ', Péron (1807, p. 234) remarks, '. . . . ils y avaient aussi vu de nombreuses truites; et M. Lesueur m'en rapportoit quelques-unes qu'il avoit tuées d'un coup de fusil '. It seems very probable that these ' truites ' were *Galaxias truttaceus*, and, on the evidence available, I venture to redesignate the type-locality of this species as Agnes River (Rivière Fleurieu of Péron), South-Eastern Tasmania. It should be noted that elsewhere Péron (1824, p. 73) mentions *Esox* among marine fishes and sharks, the reference, which may be presumed not to be a Galaxiid, possibly relating to *Dinolestes*, or *Sphyraena*.

Galaxias (Galaxias) attenuatus (Jenyns)

Mesites attenuatus Jenyns, *Zool. Voy. Beagle*, III. *Fish*. 1842. p. 121. pl. XXII. fig. 5.
Austrocobitis attenuatus Ogilby, *Proc. Linn. Soc. N.S.W.* XXIV. 1899. p. 158.
Galaxias attenuatus Regan, *Proc. Zool. Soc.* 1905. II. (1906). p. 368. pl. XII. fig. 1 and pl. XIII. fig. 2. (references and synonymy).

Distribution. Queensland (Marshall, 1928); New South Wales; Victoria; South Australia; Tasmania, and neighbouring islands; New Zealand, and neighbouring islands; Falkland Islands; Tierra del Fuego; Patagonia; Chile; &c. Type-locality: Bay of Islands, New Zealand.

Galaxias (Galaxias) rostratus Klunzinger

Galaxias rostratus Klunzinger, *Arch. Naturges.* XXVIII. 1. 1872. p. 41.

Distribution. South Australia. Type-locality: Murray River, South Australia.

Remarks. Regan (1906, p. 378), in error, cites the type-locality as ' Mersey River ', thus suggesting a Tasmanian habitat: fortunately, this slip has not crept into any of our faunal lists. The species, incidentally, does not seem to have been recognized since its description more than sixty years ago.

Galaxias (Galaxias) auratus Johnston

Galaxias auratus Johnston, *Pap. Roy. Soc. Tasm.* 1882 (1883). pp. 62 and 131.

Distribution. Tasmania. Type-locality: Great Lake, Tasmania.

Remarks. In Johnston's MS., made available by Whitley (1929, p. 48), there appears under the record of *G. atkinsoni* ('Pieman River, Tasmania, 28th Nov., '79. T. R. Atkinson') a subsequently added note: 'Mr. Irving, in early May, 1894, sent me from Great Lake one of several specimens almost identical with the above, as regards dusky bar markings, but close to the characters of *G. attenuatus* in other respects'. Unless the resemblance to *G. attenuatus* was of a most superficial character, I am at a loss to make a conjecture as to the identity of this specimen. If, however, the observation was the result of quite a casual inspection, signifying, for instance, little more than the body was slender, and the mouth small, there seems a possibility that the specimen might have been a young example of *G. (G.) parkeri*: but the available evidence is of too uncertain a character to be invested with any taxonomic significance.

Galaxias (Galaxias) weedoni Johnston

Galaxias weedoni Johnston, *Pap. Roy. Soc. Tasm.* 1882 (1883). p. 131.
? *Galaxias atkinsoni* Johnston, *Pap. Roy. Soc. Tasm.* 1882 (1883). p. 131.

Distribution. Tasmania. Type-locality: Mersey River, Tasmania.

Remarks. The relegation by Regan of *G. (G.) atkinsoni* to the synonymy of *G. (G.) weedoni* has been generally followed by Australian authors, *e.g.*, McCulloch (1929), Lord and Scott (1924, p. 33). Further evidence, particularly data derived from adult specimens, appears to be required, however, before the status of the species can be satisfactorily determined. The type-locality of *G. (G.) atkinsoni*—spelt *atkinsonii* by Regan (pp. 377 and 378)—is Pieman River, Tasmania: the specimens discussed by Regan came from Lake Laura.

In Johnston's memoranda, redacted by Whitley (1929, p. 47), there is included under the heading of *G. auratus* a note on a 'Mountain Trout. Lake Sorell'. Though it might naturally be presumed Johnston would be quite clear on the limits of one of his own species, I have, nevertheless, a suspicion that the specimen in question may possibly be referable to *G. (G.) affinis* Regan. The whole matter, however, appears too vague to warrant even a queried inclusion of the reference in the synonymy.

Galaxias (Galaxias) affinis Regan

Galaxias affinis Regan, *Proc. Zool. Soc.* 1905. II. (1906). p. 380, pl. X. fig. 1.

Distribution. Tasmania. Type-locality: Lake St. Clair, Tasmania.

Remarks. I have previously (1934, p. 39) called attention to the omission of this species from the Tasmanian lists of Lord (1923) and Lord and Scott (1924).

Galaxias (Galaxias) johnstoni, sp. nov.

(Text-fig. 1)

B. 8 [8-9]. D. III, 7 [III, 6-7]. A. III, 7 [III, 6-7]. P. 12 (IV, 8). V. 7. C. $14, \mathrm{II} + \frac{\mathrm{IX}\ +}{\mathrm{IX}\ +} \left[14,\ \mathrm{II} + \frac{c.\ \mathrm{VIII} - \mathrm{X}}{c.\ \mathrm{IX} - \mathrm{XI}} \right]$. Gill-rakers on lower limb of anterior arch 8 [7-8], moderately stout, fairly short.

Depth of body, 6·9 [7·2-7·6] in total length, 5·9 [6·1-6·6] in standard length. Head 5·9 [5·4-5·5] in total length, 5·0 [4·6-4·8] in standard length. Snout 3·4 [3·8-4·3] in head. Eye 1·4 [1·0-1·3] in snout, 2·3 [1·9-2·1] in interorbital width, 4·8 [4·3-4·6] in head. Depth of caudal peduncle 1·4 [1·4-1·7] in its length, 2·1 [2·3-2·4] in head. Length of caudal peduncle 1·4 [1·4-1·5] in its superior length (*i.e.*, interval between termination of dorsal and hypural joint), 1·3 [1·2-1·3] times base of dorsal.

Body rather slender; greatest width 1·1 [1·1-1·2] in greatest depth. Head moderate; greatest depth 1·1 [1·1-1·2] in greatest width; depth at eyes 1·1 [1·1-1·3] in width there, the latter dimension being 1·1 [1·0-1·1] times length of postorbital portion of head. Eye rather small. Interorbital region almost flat. Snout obtuse, little depressed; jaws equal [equal-subequal] anteriorly. Maxillary extending almost to level of middle [anterior ⅓—almost middle] of eye. Tubular anterior nostril nearly as wide as high; equidistant from anterior margin of upper lip and eye. Simple posterior nostril slightly in advance of, barely above, eye; nearly thrice as far from anterior nostril as from orbit.

Pores along midlateral line about 29 + 23, one to each myomere, decreasing in size caudad.

Lingual teeth rather large. Pterygoidal teeth moderate. Premaxillary teeth rather small, subequal. Mandibulary teeth moderate, somewhat enlarged laterally.

Dorsal fin moderate, fairly high; base 2·0 [1·8-1·9] in head, subequal to postorbital portion of head; longest (2nd [2nd-1st] branched) ray 1·3 [1·6-1·7] in head, more than twice snout; distance from its origin to base of caudal 4·1 [3·4-3·8] in total length, 3·5 [2·9-3·1] in standard length; laid back, extends less than half-way along superior profile of peduncle, barely reaching origin of caudal ridge.

Anal fin subequal to dorsal; base 1·8 [1·8] in head, less than caudal peduncle; longest (2nd [2nd-1st] branched) ray 1·3 [1·4-1·6] in head, less than depth of body; originating behind origin of dorsal by 0·5 [0·5-0·6] of base of latter; terminating behind base of dorsal by 0·6 [0·6] of latter; laid back, extends scarcely half-way along peduncle, reaching well past origin of caudal ridge.

Pectoral fin moderate, obtusely pointed; longest (5th [5th]) ray 1·3 [1·5-1·6] in head; extending 0·6 [0·5-0·6] of distance from its origin to origin of pelvic.

Pelvic fin moderate; longest (4th [4th]) ray 1·6 [1·7-2·0] in head; originating midway between base of caudal and anterior margin of eye; length to its origin 2·2 [2·1-2·2] in total length, 1·9 [1·8-1·9] in standard length; extending 0·6 [0·6-0·7] of distance from its origin to origin of anal.

Caudal fin moderate; emargination 10 per cent. [9-12 per cent.]; length 1·1 [1·2-1·4] in head. Caudal ridges well developed; extension cephalad from level of hypural subequal to median caudal rays.

Total length 71 mm. [49-50·5 mm.]; standard length 60·5 mm. [42·5-43 mm.].

Ground colour in life translucent greenish, becoming greyish white, shot with silvery gold, below. Back and sides irregularly blotched, obscurely barred, and reticulated with brownish. In the holotype (Text-fig. 1) and in one paratype, viewed laterally, the much-reticulated dark colour-pattern, the area of which equals, or slightly exceeds, that of the interspaced ground colour, descends, behind vent, to ventral profile, but, in advance of vent, ceases at about one-third of the body-height above ventral profile, the line of demarcation being moderately sharp. In two paratypes the broad bars of the dark colour-pattern, the area of which greatly exceeds that of the interspaced ground colour, cease above the ventral profile throughout the entire length, the line of demarcation being decidedly sharp. Dorsal markings similar to lateral, meeting a well-defined narrow median stripe of gold, extending from nape to dorsal origin: in preserved specimens this stripe, along which the body becomes sunken to form a groove, appears as a continuous, or subcontinuous, dark streak. Whole body lavishly and brilliantly punctuated with metallic gold. Head in general concolorous with body, with darker patches between and behind eyes, where there is much scattered gold, at bases of anterior nostrils, and on tip of snout; ventral surface concolorous mesially with that of body, darker laterally; lower lip scarcely lighter than upper, the latter concolorous with general dorsal surface of snout. Operculum with conspicuous metallic gold blotch. A narrow gold annulus surrounding pupil; iris otherwise blackish

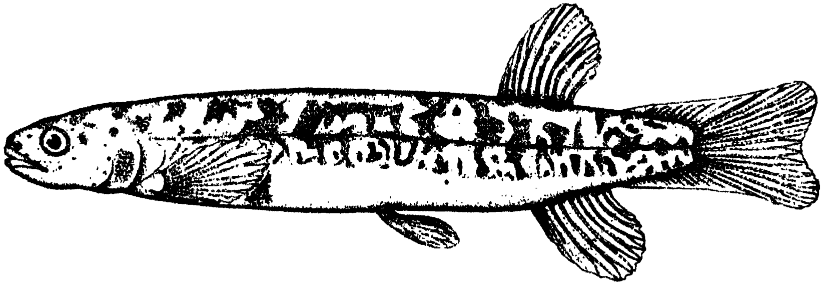

Fig. 1.—*Galaxias (Galaxias) johnstoni*, sp. nov. Holotype. Near Nive River, Tasmania. (× 1⅓.) [Parasites not shown.]

with purplish cast. No suborbital dark streak. Enteric canal metallic greenish gold. All fins immaculate, golden, in some lights presenting a metallic appearance.

Specific name in honour of Robert Mackenzie Johnston, the father of Tasmanian ichthyology, who paid considerable attention to the local Galaxiidae.

Types. Described from the holotype (Text-fig. 1) in the Queen Victoria Museum, Launceston (Reg. No. HT 948), and from three paratypes, the variations exhibited by which are recorded throughout in square brackets. Paratypes will be offered to the British Museum (Natural History), London; Australian Institute of Anatomy, Canberra; Australian Museum, Sydney.

Locality. Creek crossing the Hobart-Queenstown road, about three and three-quarter miles westward from the Nive Bridge; 31st March, 1934.

Affinities. It is convenient here to observe that the Tasmanian representatives of the subgenus fall naturally into three sections: the *truttaceus* group, comprising that species, *auratus*, and *scopus*; the *weedoni* group, comprising that species (and *atkinsoni*, if distinct), *johnstoni*, *parkeri*, and, rather towards the fringe of the assemblage, *affinis*; and the *attenuatus* group, represented locally by that species only. While the familiarity acquired from handling of actual specimens renders the relegation of any species to its appropriate group a simple matter, a formal and precise delimitation of the groups naturally presents some little difficulty. Broadly speaking, however, and allowing for occasional exceptions to individual diagnostic points, the members of the *truttaceus* group exhibit the following characters:—rather small mouth; pelvic fins inserted well back; anal fin set well forward, relative to dorsal; anal and dorsal not pointed, without macroscopic spots, often blackish distally; colour-pattern not extensive, usually in the form of spots, which are often ocellated; suborbital dark streak; relatively little metallic gold in life: members of the *weedoni* group exhibit.—rather large mouth; pelvic fins inserted moderately to well forward; anal fin set below about middle of dorsal; anal and dorsal more or less pointed, often with macroscopic spots, not blackish distally; colour-pattern extensive, usually in the form of bars, chevrons, blotches, or reticulations, seldom in spots, which, in any case, are never ocellated; no suborbital dark streak; a considerable amount of metallic gold in life: members of the *attenuatus* group (including extralimital species, *e.g.*, *G. gracillimus*, *G. maculatus*) differ from the two preceding groups by, among other characters, the small mouth, elongated body, origin of anal vertically below that of dorsal (*cf.*, however, *G. scopus*), large number of anal rays, and nature of colour-pattern.

G. (G.) johnstoni is distinguishable from all other members of the *weedoni* group by its colour-pattern. It further differs from *G. (G.) weedoni* (and *G. (G.) atkinsoni*) in the radial formulae of anal, dorsal, and pectoral; from *G. (G.) parkeri* in having fewer anal rays, jaws equal anteriorly; from *G. (G.) affinis* in having fewer anal rays, &c.

Parasites. The holotype is parasitized to a slight extent by an Opisthorchiid trematode (not shown in figure), probably congeneric with the *Clonorchis* noted by Whitley (1935, p. 51) as occurring in Galaxiids and in *Retropinna.* The distomes are encysted in the immediately subdermal tissue and the fin-membranes, where they induce local melanosis. A few scattered cysts are observable, particularly on the caudal fin, in each of the paratypes.

As Regan (1906, p. 364) has pointed out, 'in some species' of *Galaxias* these 'numerous small blackish spots on the body and fins are almost always present, and have been mistaken for colour-markings characteristic of the species (*e.g.*, *G. lynx* and *G. olidus*)'.

Galaxias (Galaxias) scopus, sp. nov.

(Text-fig. 2)

B. 8 [9]. D. IV, 8 [IV, 8]. A. IV, 10 [IV, 12]. P. 16 [15]. V. 7. $\text{C. } 14,\ \text{II} + \genfrac{}{}{0pt}{}{\text{VIII} +}{\text{VII} +}\left[14,\ \text{II} + \frac{\text{IX} +}{\text{IX} +}\right]$. Gill-rakers on lower limb of anterior arch 10 [11], long, slender.

Depth of body 6·6 [6·3] in total length, 5·5 [5·3] in standard length. Head 5·5 [5·7] in total length, 4·6 [4·8] in standard length. Snout, 3·6 [3·6] in head. Eye 1·2 [1·2] in snout, 1·9 [2·1] in interorbital width, 4·3 [4·4] in head. Depth of caudal peduncle 1·1 [1·2] in its length, 2·1 [2·1] in head. Length of caudal peduncle 1·5 [1·4] in its superior length, 1·3 [1·1] times base of dorsal.

Body stout; greatest width 1·2 [1·2] in greatest depth. Head moderate; greatest depth 1·0 [1·0] in greatest width; depth at eyes 1·0 [1·0] in width there, the latter dimension being 1·2 [1·3] times length of postorbital portion of head. Eye moderate. Interorbital region convex. Snout obtuse, little depressed; jaws equal anteriorly. Maxillary extending to level of anterior ¼ [⅛] of eye. Tubular anterior nostril higher than wide; about twice as far from eye as from anterior margin of upper lip. Simple posterior nostril above, and well in advance of, eye; nearer to orbit than to anterior nostril.

Pores along midlateral line about 40 + 22, one to each myomere.

Lingual teeth moderate. Pterygoidal teeth moderate. Premaxillary teeth fairly large, increasing somewhat in size laterally. Mandibulary teeth moderate; several more or less distinctly enlarged lateral canines; an enlarged tooth on either side near the symphysis.

Dorsal fin rather small, fairly high, base 2·4 [2·0] in head, less than, or equal to, postorbital portion of head; longest (3rd [3rd] branched) ray 1·5 [1·3] in head, two and a half times snout; distance from its origin to base of caudal 4·6 [4·6] in total length, 3·9 [3·8] in standard length; laid back, reaches half-way along superior profile of peduncle, extending beyond origin of caudal ridge.

Anal fin much longer, slightly higher, than dorsal; base 1·4 [1·4] in head, noticeably more than caudal peduncle; longest (2nd [3rd] branched) ray 1·3 [1·2] in head, more than half anal-pelvic interspace; originating behind origin of dorsal by 0·05 [0·0] of base of latter; terminating behind base of dorsal by 0·6 [0·6] of latter; laid back, extends three-fourths of the way along peduncle, reaching beyond anterior procurrent ray.

Pectoral fin moderate, rounded; longest (5th [6th]) ray 1·5 [1·4] in head; extending 0·5 [0·5] of distance from its origin to origin of pelvic.

Pelvic fin moderate; longest (3rd [3rd]) ray 1·8 [1·7] in head; originating midway between base of caudal and a point between orbit and anterior nostril [equidistant from base of caudal and eye]; length to its origin 2·3 [2·2] in total length, 1·9 [1·8] in standard length; extending 0·6 [0·6] of distance from its origin to origin of anal.

Caudal fin moderate; emargination [about 20 per cent.]; length 1·1 [1·1] in head. Caudal ridges well developed; total depth at level of hypural greater than [equal to] length of caudal peduncle.

Total length 129 mm. [114 mm.]; standard length 108·5 mm. [96 mm.].

Ground colour in formalin faintly bluish grey. Ventral surface in holotype ivory with minute dark punctulations, scarcely apparent to the naked eye; in paratype obscurely brownish from the presence of numerous stellate black pigment-spots. Holotype with lower half, or more, of sides behind level of dorsal origin with distinct yellowish suffusion. A dark, sharply defined postpectoral bar or blotch, preceded (right side of holotype), or followed (left side of holotype), or encircled (both sides of paratype) by a narrow region of pale sulphur yellow. Back and sides with numerous circular or elliptical dark purple spots of several sizes, the great majority conspicuously annulated with sulphur yellow. On the sides in advance of the anal base these cease below at about the horizontal level of middle pectoral base, but cover the whole caudal peduncle, on which the large spots are of greater dimensions than elsewhere, while small spots are few, or absent. The whole interspace between the spots, including the light-coloured annuli, thickly covered with blackish punctulations, somewhat more sparsely set in the holotype on the lower part of the caudal peduncle. Occipital region, cheek, and opercle concolorous with dorsal and lateral aspects of body; ventral surface of head concolorous with ventral surface of body; interorbital region and dorsal surface of snout darker than rest of head, markedly so in paratype, in which they are black. Upper lip very dark, almost black; posterior half of lower lip lighter than, anterior half almost concolorous with, upper lip. Broad oblique suborbital dark streak. Dorsal and anal fins with about the proximal third abundantly punctulated greyish; remainder, except tips, which are blackish, immaculate and with some indication of having been yellowish in life. Pectoral fins with membrane sparsely pigmented at base, immaculate elsewhere; rays with lateral and some medial pigmentation, rendering them somewhat dusky. Pelvic fins mainly hyaline, with small faintly ashen basal region; tips blackish. Caudal fin in holotype slightly, in paratype moderately, dusky; a dark basal region; in paratype distal region narrowly blackish. Caudal ridges minutely and abundantly punctulated: in holotype upper ridge with four or five dark spots; in paratype upper and lower ridges each with one or two spots.

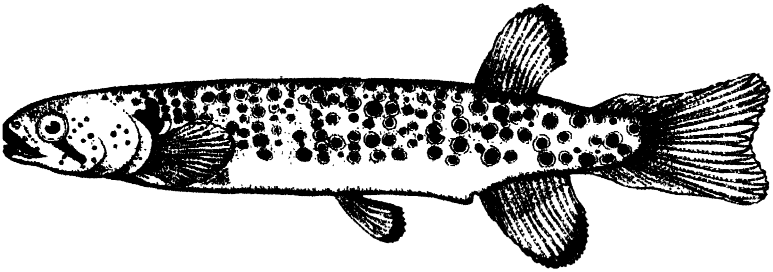

Fig. 2.—*Galaxias (Galaxias) scopus*, sp. nov. Holotype. Clarke Island, Bass Strait. (× ¾.)

Scopus, a target—in allusion to the general suggestion of resemblance, arising from the irregular, crowded distribution of the spots, to a target riddled with bullets.

Types. Described from the holotype (Text-fig. 2), in the Queen Victoria Museum, Launceston (Reg. No. HT 949), and from one paratype, which will be offered to the British Museum (Natural History), London.

Locality. Clarke Island, Bass Strait. Holotype from a 'small brackish-water stream, running very slowly indeed in hot summers, and forming a six feet deep by 400 yards long lagoon at the mouth', the specimen being caught on the 18th January, 1935, 'about 100 yards above this creek-lagoon in a rocky pool, making the distance from the sea just over a quarter of a mile'; (Mr. A. Maclaine). Paratype from another creek, flowing eastward, 'about 200-300 yards from sea; water definitely brackish', February, 1935; (Mr. G. Maclaine).

Distribution. Among some Galaxiid material recently received on loan for examination from the Australian Museum, Sydney, through the courtesy of the Director, Dr. C. Anderson, were two undetermined specimens from Flinders Island, collected many years ago by Mr. A. S. Le Souef. One of these (Aus. Mus. Reg. No. 1.A.3913), about 140 mm. in total length, is clearly *G. (G.) attenuatus*; the other (Aus. Mus. Reg. No. 1.A.3912), the total length of which is of the order of 120 mm.. is possibly referable to the present species, but is in too poor a state of preservation to admit of definite determination.

Affinities. *G. (G.) scopus* is clearly a member of the *G. (G.) truttaceus* group, from all other members of which, however, it is at once distinguished by the origin of the anal being below, or very slightly behind, the level of the dorsal origin.

It is nearest to *G. (G.) truttaceus*, from which it differs mainly in the relative positions of the anal and dorsal, as noted above, and in the more lavish spotting. Apart from these characters, it closely resembles that species, and, on the evidence afforded by the holotype alone, might naturally be suspected to be possibly merely a regional, subspecific variant of it. The subsequent capture, in the same creek as that from which the paratype was obtained, of a quite characteristic specimen of *G. (G.) truttaceus* would seem to indicate, however, that *G. (G.) scopus* is a distinct species.

Remarks. The important diagnostic character of the point of origin of the anal relative to that of the dorsal may probably be with advantage the subject of more precise investigation than it has customarily received hitherto: it is not unlikely that the adoption of a convenient quantitative notation, followed by its application to extensive series of specimens, may prove of value, not only in indicating specific, but also in revealing and assessing subspecific, differences, the latter, incidentally, being a taxonomic aspect that is as yet scarcely touched upon in the case of members of the present order.

In the formulae discussed below, D and d denote, respectively, length to origin, and to termination, of base of dorsal; A and a, respectively, length to origin, and to termination, of base of anal; T, total length; S, standard length (*i.e.*, from tip of snout to hypural joint). Employing a slight modification of the expression $\frac{a-d}{t} \times 100$ (a = length to vent; d = length to dorsal; t = total length) used with striking success by Schmidt (1928) in the investigation of our Australian eels, we find $\frac{A-D}{T} \times 100$ gives the following values: *G. (G.) scopus* 0-0·4; *G. (G.) truttaceus* (one specimen, total length 134 mm.; Clarke Island) 2·6; *G. (G.) truttaceus* (ten specimens, total length 82-141 mm.; various Tasmanian localities) 2·1-3·1, av. 2·4.

Substituting S for T, the values, noted in the same sequence, are: 0-0·5; 3·1; 2·4-3·6, av. 2·8. After making trial of various formulae, involving such factors as head-length, eye-diameter, length and depth of caudal peduncle, pelvic-anal interspace, and so on, I find perhaps the most useful to be $\frac{A - D}{(d - D) + (a - A)} \times 100$: this yields satisfactorily consistent results, with the values of a convenient magnitude, and, further, introduces the appropriate factors of the lengths of the bases of the fins under consideration. The values derived from this formula, in sequence as before, are: 0-2·0; 14·3; 10·6-14·5, av. 11·9.

Galaxias (Galaxias) parkeri, sp. nov.

(Text-fig. 3)

B. 8 [8-9]. D. IV, 7 [IV-V, 6-9]. A. IV, 9 [IV-V, 7-9]. P. 14 [14-15]. C. 14, II $+ \frac{c.\ \mathrm{X}}{c.\ \mathrm{IX}} \left[14,\ \mathrm{II} + \frac{\mathrm{V} + - \mathrm{IX}}{\mathrm{V} + - \mathrm{X}} \right]$. Gill-rakers on lower limb of anterior arch 9 [8-9], fairly long.

Depth of body 7·2 [5·9-12·0] in total length, 6·2 [5·0-10·3] in standard length. Head 5·3 [5·2-6·9] in total length, 4·5 [4·5-5·9] in standard length. Snout 3·3 [3·1-3·8] in head. Eye 1·3 [1·2-1·9] in snout, 1·9 [1·6-2·6] in interorbital width, 4·3 [3·9-6·2] in head. Depth of caudal peduncle 1·5 [1·3-1·7] in its length, 2·2 [2·0-3·1] in head. Length of caudal peduncle 1·5 [1·2-1·4] in its superior length, 1·8 [1·4-1·8] times base of dorsal.

Body rather slender; greatest width [1·0-1·2] in greatest depth. Head moderate; greatest depth 1·1 [1·1-1·3] in greatest width; depth at eyes [1·1-1·4] in width there, the latter dimension being [1·0-1·3] times postorbital portion of head. Eye moderate. Interorbital region almost flat, or even slightly concave. Snout obtuse, much depressed; upper jaw protecting beyond lower. Maxillary extending to level of middle [anterior margin or barely beyond, in small paratype – anterior ⅓ or middle in larger paratypes] of eye. Tubular anterior nostril a little higher than wide; rather nearer anterior margin of upper lip than eye. Simple posterior nostril level with, or slightly in advance of, eye, barely above eye; about thrice as far from anterior nostril as from orbit.

Pores along midlateral line about 41 + 20, one to each myomere.

Lingual teeth rather small. Pterygoidal teeth rather small to moderate. Premaxillary teeth moderate, subequal. Mandibulary teeth moderate, scarcely enlarged laterally.

Dorsal fin rather short, of moderate height; base 2·7 [1·6-2·7] in head, rather more than, or subequal to, postorbital portion of head; longest (1st [1st-2nd] branched) ray 1·6 [1·6-2·1] in head, slightly more than [subequal to] twice snout; distance from its origin to base of caudal 4·0 [3·8-4·3] in total length, 3·4 [3·2-3·6] in standard length; laid back, extends less than half-way along superior profile of peduncle, barely, or not, reaching origin of caudal ridge.

Anal fin rather longer than, subequal in height to, dorsal; base 2·1 [1·4-2·5] in head, less than caudal peduncle; longest (2nd [2nd-3rd] branched) ray 1·6 [1·5-2·0] in head, less than depth of body; originating behind origin of dorsal by 0·5 [0·5-0·6] of base of latter; terminating behind base of dorsal by 0·7 [0·5-0·7] of latter; laid back, extends half-way, or less, along caudal peduncle, reaching beyond, or barely to, origin of caudal ridge.

Pectoral fin moderate, obtusely pointed; longest (6th [6th-8th]) ray 1·6 [1·4-1·9] in head; extending 0·5 [0·4-0·6] of distance from its origin to origin of pelvic.

Pelvic fin moderate; longest (4th [4th]) ray 1·5 [1·3-1·9] in head; extending 0·6 [0·4-0·6] of distance from its origin to origin of anal. The point of insertion exhibits considerable variation, correlated, in the main, with size: in the holotype it is about equidistant from base of caudal and anterior margin of eye; in the larger and moderate-sized paratypes it lies midway between base of caudal and vicinity of anterior nostril; while in small paratypes (and in other small individuals, including one of the 12 specimens, 42-50 mm. in length, forwarded to the British Museum by Mr. Critchley Parker, which I have been able to examine through the courtesy of Mr. J. R. Norman) it lies at, or even decidedly in advance of, the middle of the standard length. Length to origin is hence rather variable, being 2·2 [2·1-2·4] in total length, 1·9 [1·9-2·1] in standard length.

Caudal fin moderate; emargination 14 per cent. [14-19 per cent.]; length 1·4 [1·0-1·6] in head. Caudal ridges well developed; extension cephalad from level of hypural subequal to median caudal rays.

Total length 79 mm. [45-113 mm.]; standard length 68 mm. [38·5-99 mm.].

Colour of holotype (in alcohol) pale brownish, heavily barred with dark slate grey, the number (round about ten) and size of the bars differing on the two sides; the widest bar, near the dorsal fin, involves about ten myomeres, its width being about equal to the length of the pectoral. At level of midlateral line, the bars of ground colour vary in breadth from about one-quarter, anteriorly, to one-third or one-half, posteriorly, of the width of the dark bars. The dark areas, which, except on and near the caudal peduncle, fail to reach the ventral profile, are continued up from the sides in irregular broad saddles over the back. A narrow bluish postpectoral bar. Lower lateral and ventral aspects of body yellowish white, punctulated with bluish grey, except for an immaculate median area, less than one-third as wide as the body, that extends from level of pectorals nearly to level of pelvics. Sides of head in general concolorous with sides of body; an ill-defined dark spot on operculum, the postero-inferior portion of which latter is lighter than most of head; dorsal surface in general concolorous with sides, but with darker interocular and occipital patches; lower lip rather lighter than upper. No suborbital dark streak. Dorsal and anal fins immaculate macroscopically; yellowish grey, darker and with tinges of green basally, where there is abundant dark punctulation; well-developed ridges, probably originally yellowish, extending up between the rays for about three-quarters of their length. Pectoral and pelvic fins immaculate macroscopically; yellowish grey, somewhat dusky distally; scattered punctulations near base. Caudal fin pale yellowish grey, somewhat dusky distally; a few punctulations on proximal third.

Colour in life of a large paratype, 77·5 mm. in total length (*i.e.*, about same size as holotype), brown, more or less olivaceous; barred and blotched with darker brown, becoming somewhat greenish anteriorly. Along mid-dorsal line, from nape to origin of dorsal, a linear series of about eight narrow dark brown stripes, narrowly margined on either side with gold specks. A dark brown midlateral ridge clearly traceable backwards to origin of dorsal. Sides below midlateral line moderately punctulated with gold. Narrow dark post-pectoral bar. Ventral surface pale green. Head in general concolorous with body; dorsal surface of snout a characteristic pale jade green, with golden spot near base of each anterior nostril; upper lip dark greenish, faintly brown; lower lip pale greenish. Operculum with golden green blotch, not very sharply delimited. Iris silvery green, much punctulated, especially above, with brown. No suborbital dark streak. Dorsal and anal fins green proximally, brown-orange mesially, ashen distally. Pectoral fin brownish, with a narrow almost white region at tip, and extending somewhat inwards along postaxial border. Pelvic fin similar to pectoral, but with two or three of the anterior rays darker distally. Caudal fin rich brown, with a suffusion of orange; ashen distally; rays rich brown up to the bifurcation, thereafter either ashen or dusky.

The ground colour in life of moderate-sized specimens (50-60 mm. in total length) is commonly green, varying in depth in different individuals; body-markings dark green. Fins mainly greenish or hyaline. Other details much as in large paratype described above.

Specimens of about the size of the smallest paratype (45 mm. in total length), and smaller, are in general pale greenish, translucent—appearing, however, much darker, almost dark greenish brown, when viewed swimming at some distance below the surface. The colour-pattern varies greatly, and may be well-developed, inconspicuous, or almost entirely absent. Small black spots on dorsal surface, irregularly scattered, except for two well-marked rows embracing base of dorsal fin. Narrow dark midlateral line. Snout translucent, often faintly greenish; olfactory sacs metallic green-gold punctulated with blackish. Occipital patch green-gold, submetallic. Superior aspect of ocular capsules orange-gold, scintillant—a very conspicuous feature in life, the spots being clearly visible even under a depth of a couple of feet of water, and giving a curious illusion of self-luminosity. Upper lip pale green, but darker than lower. Metallic green-gold spot on operculum. Iris greenish silver, speckled with blackish. Fins colourless, or sometimes (especially vertical fins) faintly green; caudal fin occasionally slightly dusky distally. Enteric canal golden green. Vertebrae forming a series of greenish or blackish subrectangular blocks.

Specific name in honour of Mr. Critchley Parker, who collected, and presented to the British Museum, the holotype and about a dozen smaller individuals.

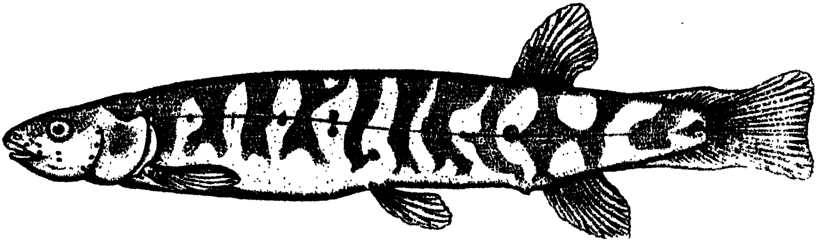

Fig. 3.—*Galaxias (Galaxias) parkeri*, sp. nov. Paratype. Great Lake, Tasmania. (× 1¼.)

Types. Described from the holotype, in the British Museum (Natural History), London, and from nine paratypes, the variations exhibited by which are recorded throughout in square brackets. A paratype figured (Text-fig. 3). Two paratypes in the Queen Victoria Museum, Launceston (Reg. Nos. PT 950, a-b). Paratypes will be offered to the British Museum (Natural History), London; Australian Institute of Anatomy, Canberra; Australian Museum, Sydney; National Museum, Melbourne; Tasmanian Museum, Hobart; Museum of the Department of Biology, University of Tasmania, Hobart; Museo Argentino de Ciencias Naturales, Buenos Aires.

Locality. Holotype from Great Lake (about off Howell's Neck), Tasmania; caught, on artificial fly, by Mr. Critchley Parker, April, 1934. Paratypes from streams running into the Great Lake at northern end (Little Lake), near Duck Point, and at Reynold's Neck; January, March, April, 1934, February, 1935.

Distribution. In May, 1935, I obtained specimens of this species, collected in ice-covered pools, at Tangled Tarns, in an unmapped region of the Central Plateau, lying on Ritter's track, westward from the Chudleigh Lakes.

Habits. G. (G.) parkeri is common in the Great Lake, and in creeks running into it, its frequency in that locality being at the present time equal to, if not greater than, that of *G. (G.) truttaceus:* these two species appear to be the only forms found in the lake in recent years.

In the streams the smaller individuals occur chiefly near the lake, the larger individuals being met with as a rule from three or four hundred yards to a mile, which is as far as I have as yet had opportunity to trace them, inland. Observations made in February, 1935, showed that, at that time, the younger individuals in the creeks and ditches migrated in large numbers into the lake near sunset, returning in shoals shortly after daybreak, belated examples entering the streams, however, throughout most of the morning.

Specimens at present in captivity exhibit the general habits of the genus, but are characterized by the peculiar attitude of repose noted below. Unless the aquarium has a considerable height above the water-line, it must be kept covered, *e.g.*, with flywire, since, like other species of the genus, the present form is capable of leaping clean out of a tank the walls of which rise five or six inches above the level of the water.

Moderate-sized individuals, fed twice a week, consume a couple of worms at each meal, the hungry fish often struggling vigorously for the food. During the months of May, June, and July, their appetite is not so keen, and they are satisfied with one small meal per week.

When at rest, *G. (G.) parkeri* lies upon the bottom in a peculiar attitude, curiously suggestive of a tetrapod in repose. The whole body is held approximately horizontal, the head being little, if at all, raised; the tail, and frequently the posterior part of the trunk as well, is strongly curved to the right or left; the pectoral and pelvic fins are held motionless, splayed out, their tips resting on the bottom, the preaxial border of the former and the postaxial border of the latter elevated. This attitude, which is generally similar to, though perhaps not identical in detail with, that assumed by some other members of the *weedoni* group, is very different from the resting posture of *G. (G.) truttaceus*, in which species the general level of the body is much higher in front than behind, the head being held well above the bottom; the tail is not, or scarcely, curved; and the pectoral fins are kept in constant motion.

As in other members of the genus, the pectoral fins are commonly furled close to the sides during short bursts of swimming.

Affinities. *G. (G.) parkeri* belongs to the *weedoni* group, from the other members of which it is rather clearly distinguished by its colour-markings. On the whole, it is nearest to *G. (G.) weedoni.* Mr. J. R. Norman, who has compared the holotype with the specimen, 110 mm. in length, forwarded to the British Museum by Johnston in 1880, which Regan (1906) determined and figured (Pl. XI, fig. 1) as *G. weedoni*, observes that the latter differs from the type of *G. parkeri* 'chiefly in the more slender body, rather larger eye, stronger teeth in the lower jaw and on the tongue, and in the coloration'. On comparing the paratypes of *G. (G.) parkeri* with a specimen of *G. (G.) weedoni*, total length 133 mm., standard length 115 mm., in the Australian Museum, Sydney (Aus. Mus. Reg. No. 1. 7431), recorded, in a memorandum by Waite, as being one of the actual examples used by Regan in his revision, I find that these features appear to be constant. The type of *G. (G.) weedoni* has been lost, but Whitley (1929) has made available Johnston's notes on, and sketch of, a specimen, which, judging from the general context and from the dimensions given, appears clearly to be the type—indeed, the figure is so designated by Whitley. This specimen has the head 22 mm. long, and the 'body' (comparison with the figure, which is about 0·93 natural size, shows standard length is meant) 97 mm. The 'more slender body' and 'rather larger eye' of *G. (G.) parkeri*, noted by Mr. Norman as characterizing his material, hold good here. Johnston's sketch seems to depict an individual with rather less marbling of the sides than the example figured by Regan. To these differences may be added the rather more posterior insertion, in moderate-sized or large individuals, of the pelvics in *G. (G.) parkeri* (*G. (G.) weedoni*, it may be recalled, is placed in Regan's *Synopsis of the Species* within the section, 'Origin of ventrals equidistant from tip of snout and base of caudal'), and perhaps the rather longer head, and longer caudal peduncle, relative to the total length, in the present species. Apart from its colour-pattern, *G. (G.) parkeri* differs from *G. (G.) johnstoni* notably in its more numerous anal rays, and its projecting upper jaw; and from *G. (G.) affinis* chiefly in its longer pectoral, longer caudal peduncle, relative to total length and to head, more pointed dorsal and anal, and more depressed snout.

A reference by Johnston to a specimen that may possibly be referable to this species has already been noted in the section of the present paper dealing with *G. (G.) weedoni.*

Parasites. Seven specimens, obtained from streams running into the northern end of the Great Lake, in January, 1934 (from which series one paratype has been selected), are very heavily parasitized by the Opisthorchiid trematode already mentioned as attacking *G. (G.) johnstoni.* The cysts, of which there may be more than a hundred in a square centimetre, commonly give the fish a distinctly verrucose appearance, and may entirely obscure the colour-pattern. It is of interest to observe that of twenty-two individuals of *G. (G.) truttaceus*, collected at the same time, not one exhibits any signs at all of infection.

In another series, comprising five *G. (G.) parkeri* and seven *G. (G.) truttaceus*, collected in streams running into the Great Lake, near Duck Point, in April, 1934, all specimens of the former species are parasitized, though to a decidedly lesser extent than those of the series noted above, while all those of the latter are without apparent signs of infection.

Examples of *G. (G.) parkeri* secured on other occasions are in general wholly free of this parasite.

Under unfavourable conditions in captivity, and presumably also in a state of nature, this species, like most others, is liable to be attacked by a *Saprolegnia.*

History. The holotype and 12 smaller specimens, 42-50 mm. in length, were collected by Mr. Critchley Parker, and forwarded by him to the British Museum, where Mr. J. R. Norman at once recognized the novelty of the form, and drew up a manuscript description of it. Learning, however, that I was working on the Tasmanian Galaxiidae, Mr. Norman very generously handed over his notes to me and forwarded one of the small individuals, with the request that I should describe the species. As I already possessed examples of this form, which I proposed to describe, and as, moreover, I had an opportunity of making full notes on, and a rough colour-sketch of, the holotype prior to its despatch to England, I have accepted with pleasure Mr. Norman's courteous proposal. For the accuracy of the present account, which has been drawn up independently of Mr. Norman's description, I must, of course, assume full responsibility.

Subgenus **Agalaxis,** nov.

Diagnosis. Pelvic fin with 6 rays.

Orthotype. *Cobitis zebratus* Castelnau = *Galaxias (Agalaxis) zebratus* (Castelnau).

Cobitis zebratus Castelnau, *Mem. Poiss. Afrique Austr.* 1861. p. 56.
Galaxias capensis Steindachner, *Sitzb. Akad. Wien.* CIII. 1894. p. 460. pl. III. fig. 2.

Scope. The subgenus comprises the orthotype and *Galaxias (Agalaxis) punctifer* (Castelnau), 1861.

Distribution. South Africa.

Remarks. The presence of only six rays in the pelvic fin in South African species of *Galaxias* appears to be worthy, particularly in view of the correlation of this character with distribution, of subgeneric recognition.

Agalaxis, an anagram of *Galaxias.*

Genus **Saxilaga,** nov.

Diagnosis. Body elongate. Dorsal fin inserted well back; free of, or obscurely continuous with, caudal ridge; relatively low; with 11-12 simple or mixed rays, all, or some, of which are compressed, clumsy. Anal fin about opposite dorsal; obscurely continuous with caudal ridge; relatively low; with 10-13 rays, similar to those of dorsal. Pelvic fins present; reduced in size; with 6 or 5 rays. Premaxillary and mandibulary teeth uniserial, conical, moderately acute. Entopterygoids toothless. Lingual teeth in two or more series. Eye rather small to small; with free circular lid.

Agrees with *Galaxias*, and differs from *Neochanna*, in possessing pelvic fins: differs from *Galaxias*, and agrees with *Neochanna*, in lacking teeth on the entopterygoid. Apparently an annectant form between these two genera.

Orthotype. *Galaxias cleaveri* Scott.

Saxilaga, an anagram of *Galaxias*.

Subgenus **Saxilaga,** nov.

Diagnosis. Pelvic fin with 6 rays. Lingual teeth biserial.

Orthotype. *Galaxias cleaveri* Scott = *Saxilaga (Saxilaga) cleaveri* (Scott).

Scope. The subgenus comprises the orthotype and *Saxilaga (Saxilaga) anguilliformis*, sp. nov.

Distribution. Tasmania.

Saxilaga (Saxilaga) cleaveri (Scott)

Galaxias cleaveri Scott, *Pap. Roy. Soc. Tasm.* 1933 (1934). p. 41. pl. VI.

Remarks. This Galaxiid, with the pelvics reduced, and with only six rays, with the rounded caudal—the last two characters being strangely reminiscent of the South African *Galaxias (Agalaxias) zebratus*—and with other unusual features, has hitherto proved something of an anomaly; and in describing the species, which is based on a unique holotype, met with in exceptional circumstances, I observed (1934, p. 46): 'While it is with some diffidence that I venture to create, on the strength of a single specimen, a new species in a family so variable as the Galaxiidae, this seems to be, on the available evidence, the only honest course, and is accordingly followed'.

The recent discovery of *S. (S.) anguilliformis* not only justifies the recognition of the present as a genuine and distinct form, but also provides the necessary clue to its affinities, since a re-examination, accompanied by a slight dissection, of the holotype discloses the palate to be edentulous.

In possessing both simple and branched rays in the dorsal and anal fins this species presents a greater resemblance to *Galaxias*, and departs further from *Neochanna*, than do the other species of *Saxilaga*. The branched rays, however, still exhibit something of the peculiar appearance that seems to characterize some at least of the fin-rays in this genus. Of the '22 major rays' noted in the description of the species, 16 only are compressed primary rays, the remainder being merely the enlarged posterior procurrent rays.

Saxilaga (Saxilaga) anguilliformis, sp. nov.

(Text-fig. 4)

B. 9 [9]. D. 12 [12]. A. 13 [12]. P. 14 [12]. V. 6. C. 16 + $\frac{4}{4}$. Gill-rakers on lower limb of anterior arch 8, snout, conical.

Depth of body 7·9 [7·8] in total length, 7·2 [7·2] in standard length. Head 6·3 [6·3] in total length, 5·7 [5·8] in standard length. Snout 4·8 [4·7] in head. Eye 1·2 [1·4] in snout, 2·4 [2·9] in interorbital width, 5·8 [6·5] in head. Depth of caudal peduncle 1·3 [1·3] in its length, 1·2 [1·2] in head. Length of caudal peduncle 1·2 [1·3] in its superior length, 1·1 [1·1] times base of dorsal.

Body slender, anguilliform; greatest width 1·05 [1·05] in greatest depth. Head rather small, scarcely marked off from body; greatest depth 1·2 [1·1] in greatest width; depth at eyes 1·2 [1·2] in width there, the latter dimension being 1·1 [1·1] times length of postorbital portion of head. Eye small. Interorbital region convex. Snout obtuse, little depressed; lower jaw projecting slightly beyond upper. Maxillary extending to slightly behind level of anterior margin of eye. Tubular anterior nostril conspicuous, rather higher than wide; rather nearer anterior margin of upper lip than eye. Simple posterior nostril above, and slightly in advance of, eye; about twice as far from anterior nostril as from orbit.

Head with pores of three sizes.[1] Pores along midlateral line about 48 to level of vent, in general one to each myomere: behind the level of the vent, where there are about 25 myomeres, the pores are not countable with certainty.

Lingual teeth biserial, rather large, fairly acute. No pterygoidal teeth. Premaxillary teeth moderate, conical, moderately acute, subequal. Mandibulary teeth moderate, conical, moderately acute; several more or less distinctly enlarged lateral canines.

Dorsal fin long, low; all rays simple; base 1·4 [1·3] in head, less than caudal peduncle, subequal to depth of body; vertical height 3·2 [3·3] in head, less than combined eye and snout; longest (6th [6th]) ray 2·4 [2·3] in head, equal to interorbital width; distance from its origin to base of caudal 4·0 [4·0] in total length, 3·7 [3·7] in standard length; laid back, reaches caudal ridge; a thick fleshy sheath, rising anteriorly, where it is highest, to tip of second ray, envelops basal half of fin.

Anal fin slightly longer than, subequal in height to, dorsal; all rays simple; base 1·3 [1·2] in head; subequal to caudal peduncle; vertical height 3·2 [3·3] in head; longest (6th [6th]) ray 2·1 [2·6] in head; originating behind origin of dorsal by 0·1 [0·1] of base of latter; terminating behind base of dorsal by 0·2 [0·2] of latter; laid back, fails to attain base of caudal by a distance subequal to depth of caudal peduncle; with fleshy basal pad, similar to that of dorsal; obscurely joined by thick membrane to caudal ridge.

Pectoral fin small, rounded; three or four of the median rays feebly cleft for about 1/10 of their length, the rest simple; longest

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[1] It is highly probable that, examined by the methods used with such striking success by Sanzo (1911), de Buen (1923), and others in the investigation of the topography of the openings of the mucus-canals and goniopores in the Gobiidae, these cephalic pores would prove of diagnostic value.

(9th [6th]) ray 1·8 [2·2] in head; extending 0·3 [0·2] of distance from its origin to origin of pelvic.

Pelvic fin small; longest (3rd [3rd]) ray 2·8 [2·9] in head, 16·5 [18·3] in total length; originating midway between caudal base and eye; length to its origin 2·2 [2·1] in total length, 1·9 [1·9] in standard length; extending 0·3 [0·2] of distance from its origin to origin of anal.

Caudal fin truncate rounded [feebly emarginate]; small, length 1·7 [2·0] in head, subequal to depth of caudal peduncle. Procurrent rays, except the posterior three or four, deeply buried in fleshy caudal ridge.

Total length 91 mm. [82 mm.]; standard length 82·5 mm. [75·5 mm.].

Ground colour (in formalin) greenish grey, paler beneath. Sides of body heavily barred and blotched with dark greenish brown; about eight or ten fairly regular forwardly convex bars, once to twice as wide as their interspaces, in advance of pelvics, behind which the markings, though in some cases still traceable as bars, tend in general to break up into blotches and reticulations of irregular form and varying size. No special shoulder-bar. Dorsal surface with numerous dark blotches, and vermiculate markings. Ventral surface macroscopically immaculate, minutely and sparsely punctulated with dark green. Head in general concolorous with body, heavily spotted dorsally, and, except for portion of cheek, laterally, with dark greenish brown; a triangular region, whose base embraces the eyes and whose apex about reaches the occiput, decidedly darker than rest of head; lips concolorous with lower part of operculum, which is greenish slate; ventral surface abundantly punctulated with greenish and greenish brown. Iris dark blue, with a lighter semilunar streak overarching pupil; no suborbital dark streak. Dorsal and anal fins with membrane hyaline, with microscopic brownish spots; lateral borders of rays dark; fleshy basal sheath greenish, with a few dark spots and numerous punctulations. Pectoral and pelvic fins virtually colourless, with scattered punctulations, most numerous basally; tips of rays of former dusky. Caudal fin greenish hyaline, the membrane marked with microscopic greenish brown spots; at base an irregular arc of conspicuous dark spots, with indications of the existence of two further, more external, concentric arcs of brownish. Caudal ridges each with eight or ten well-marked dark spots.

Specific name in allusion to the general eel-like facies.

Types. Described and figured from the holotype (Text-fig. 4) in the Queen Victoria Museum, Launceston (Reg. No. HT 951), with variations exhibited by a paratype, which will be offered to the British Museum (Natural History), London, recorded throughout in square brackets. The paratype lacks the left ventral fin, the loss having apparently occurred during life.

Locality. Creek, known locally as Cox's Creek, running into the Inglis River at Wynyard, North-Western Tasmania. Caught, on hook and line, by Master N. Blackwell, where the creek runs through Dead Horse Gully; forwarded by Mr. James Harrison, 11th December, 1934. During the course of a short visit to the locality by the writer, on 27th December, on which occasion no further specimens of the present form were secured, it was observed that the stream was inhabited abundantly by *Galaxias (Galaxias) attenuatus*, and less abundantly by *G. (G.) truttaceus*.

Habits. The general structure strongly suggests the fish is adapted to live in muddy situations.

Major R. E. Smith, Launceston, informs me that a Galaxiid that he identifies with the present form occurs in swamps near the mouths of the Forth River and the Clayton Rivulet, being known locally as 'mud-trout'. While it is not unlikely that this mud-trout may be *S. (S.) cleaveri* instead of, or in company with, *S. (S.) anguilliformis*, there is good reason to believe it to be, at any rate, some member of the present genus. Major Smith states: 'In habits it differs very much [*i.e.*, from *G. (G.) attenuatus* and *G. (G.) truttaceus*]. It is generally found when drains are being cleaned out, and seems to be actually dug out of the mud. In swamps and drains that have completely lost all trace of water they can be found in damp mud. I have often got them by turning over logs and stones where they are to be found in mud. Like an eel they will live a long time out of water'.

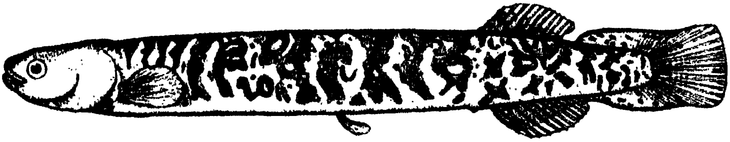

Fig. 4.—*Saxilaga (Saxilaga) anguilliformis*, sp. nov. Holotype. Cox's Creek, Tasmania. Natural size.

Affinities. *S. (S.) anguilliformis* presents, on the whole, a more neochannoid facies than *S. (S.) cleaveri*. It differs from the latter species chiefly in having the dorsal and anal rays more numerous, and all simple, instead of mixed; markedly more forwardly placed anal, the $\frac{A - D}{(d - D) + (a - A)} \times 100$ value being 4·5-4·9, as against 22·2 for *S. (S.) cleaveri*; larger eye; shorter snout; and perhaps also in the rather stouter body, and rather shorter head.

Remarks. A burrowing Galaxiid has been noted from Tasmania by Hall (1901, p. 65). This, however, was stated to be 'clearly a *Galaxias*'. Hall's specimen, which has never been properly determined, may possibly be referable, if it is indeed a *Galaxias*, to *G. (G.) atkinsoni* Johnston, generally regarded as a synonym of *G. (G.)*

weedoni Johnston. Verbal reports of a burrowing Galaxiid in Tasmania have previously been noted by the present writer (1934, p. 43).

Hall also observes: 'Fish are reported as being occasionally dug up in the "button-grass country" on the west coast of the island, and are stated by a miner to have no eyes, though otherwise similar'. For some time past I have been endeavouring, so far without success, to obtain specimens of a blind, or almost blind, Galaxiid said to occur near Marrawah. It seems not unlikely that these reports relate to *Saxilaga*; though the possibility of *Neochanna*, or of some quite unknown form, occurring in Tasmania is not altogether to be discounted.

Subgenus **Lixagasa**, nov.

Diagnosis. Pelvic fin with 5 rays. Lingual teeth in more than two series.

Orthotype. *Galaxias burrowsius* Phillipps = *Saxilaga (Lixagasa) burrowsius* (Phillipps).

Galaxias burrowsius Phillips, *Trans. N.Z. Inst.* 56. 1926. p. 531. pl. 88 (issued separately 26th April, 1926).

Scope. The subgenus comprises only the orthotype.

Distribution. New Zealand.

Lixagasa, an anagram of *Galaxias.*

Remarks. Phillipps (1926 (b), p. 532) observes of the subgenotype that it is 'undoubtedly a degenerate form of *Galaxias*, and to some extent a connecting link between *Galaxias* and *Neochanna*'. He notes that the two type-specimens, from West Oxford, in the South Island, packed in damp earth, survived a journey by post of over thirty hours; and gives an interesting account of the aestivation of this species in coconut-shaped holes in the ground.

Subfamily *PARAGALAXIINAE*, nov.

Diagnosis. Dorsal fin inserted well back, about over pelvic fins, the length to origin of dorsal being less than one-half total length. Pelvic fins present. Premaxillary and mandibulary teeth biserial or uniserial. Entopterygoid toothed. Lingual teeth in two series. [Vertebrae less than 50 in *P. shannonensis.*]

Type-Genus. *Paragalaxias* Scott, 1935.

Scope. The subfamily comprises the genus *Paragalaxias* and *Galaxias dissimilis* Regan.

Distribution. Tasmania. New South Wales(?).

Remarks. Judged solely on its external features, *Galaxias dissimilis* Regan, a figure of which has been made available by Whitley (1933), would appear to be congeneric with *Paragalaxias shannonensis*; and I have already pointed out (1935, p. 45) that its status could be satisfactorily determined only as the result of a re-examination of the dentition. At my request, Mr. J. R. Norman, of the British Museum, has very kindly made an examination of the unique holotype of the species, and now informs me (*in lit.*) that the teeth in the jaws are in a single series. Mr. Whitley's proposed generic name, *Querigalaxias*, mentioned earlier, will be available for the species when formally completed.

Genus **Paragalaxias** Scott, 1935.

Diagnosis. Body moderately elongate. Dorsal fin inserted well forward; free of caudal; relatively high; with 12-15 rays, which are mixed, or simple. Anal fin inserted well back, originating far behind dorsal, in normal Galaxiid position: free of caudal; moderately high; with about 9 rays, which are mixed, or simple. Pelvic fins present; with 6 rays. Premaxillary and mandibulary teeth biserial or uniserial, subconical, pointed. Entopterygoids each with a single series of teeth. Lingual teeth biserial. Eye small; with free circular lid. Vertebrae 44 (in *P. shannonensis*).

Orthotype. Paragalaxias shannonensis Scott.

Paragalaxias shannonensis Scott, *Pap. Roy. Soc. Tasm.* 1934 (1935), p. 41, pl. III, and text-figs. 1-2.

Scope. The genus includes only the orthotype.

Distribution. Tasmania.

Type-locality. Shannon River, Tasmania.

SUMMARY

1. The scope and interest of the Tasmanian Galaxiid fauna are noted, and some general remarks on taxonomy are made.

2. Two new subfamilies of Galaxiidae, namely, Galaxiinae and Paragalaxiinae, are instituted.

3. Two new subgenera of *Galaxias* Cuvier, namely, *Galaxias* and *Agalaxis*, are proposed.

4. A new genus, *Saxilaga*, with two subgenera, *Saxilaga* and *Lixagasa*, is diagnosed.

5. A key to the subfamilies, genera, and subgenera dealt with is provided.

6. Previously described Tasmanian species are listed, and, where necessary, commented upon: *Galaxias rostratus* Klunzinger is shown not to be Tasmanian; *G. cleaveri* Scott is referred to *Saxilaga*, nov.; the type-locality of *G. truttaceus* (Cuvier) is fixed.

7. New species described, and figured, are: *Galaxias (Galaxias) johnstoni*, *Galaxias (Galaxias) scopus*, *Galaxias (Galaxias) parkeri*, and *Saxilaga (Saxilaga) anguilliformis*.

The present communication is the second of a series, the preparation of which has been facilitated by the granting of a Research Scholarship by the University of Tasmania. It is desired here to repeat the acknowledgements made in a previous paper (1935) of assistance received from the Board of Studies, and from Mr. V. V. Hickman, B.A., B.Sc., Ralston Lecturer in Biology. For the opportunity of examining the material in the Australian Museum, Sydney, noted in the text, thanks are tendered to the Director, Dr. Charles Anderson.

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PAP. & PROC. ROY. SOC. TASMANIA, 1935 (17TH AUGUST, 1936)

Observations on Some Tasmanian Fishes

Part III

By

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(Read 30th September, 1935)

The present paper, the precise scope of which is summarized in the concluding paragraph, follows the general plan of previous communications under the same title (1934, 1935).

Registration numbers are those of the Queen Victoria Museum, Launceston.

Family HAPLOCHITONIDAE

Genus **Lovettia** McCulloch, 1915

Lovettia sealii (Johnston)

Haplochiton sealii Johnston, *Pap. Roy. Soc. Tasm.* 1882 (1883), p. 128.
Lovettia sealii McCulloch, *Proc. Linn. Soc. N.S.W.* xl. 2. 1915, p. 259, pl. XXXV, fig. 2.

Whitebait-Constituent. Johnston has noted the appearance of this species in large shoals in the Derwent, near New Norfolk, in October and November, the females then being full of mature ova.

In two samples of 'whitebait', each containing 200 individuals, purchased in Launceston fish-shops, the first sample, consisting of material from the Tamar River, on 17th September, 1934, the second, consisting of material from the Mersey River, near Latrobe, on 14th September, 1935, this species was found in each case to be easily the dominant constituent. First sample: 192 *L. sealii* (total length 41·5-56 mm.); 7 *Galaxias attenuatus* (44-52 mm.); 1 *Galaxias sp.*, probably *G. truttaceus* (58 mm.). Second sample: 172 *L. sealii* (55-65 mm.); 23 *Galaxias attenuatus* (38·5-52 mm.); 5 *Galaxias sp.*, probably *G. truttaceus* (49-65 mm.). As an indication of its abundance, it may be noted that whitebait is sold in Launceston at the rate of between two hundred and three hundred fish for a penny.

The results of these analyses are rather surprising, as it is generally believed, in view of the statements of Johnston (1883, p. 62) on the subject, that the Tasmanian 'whitebait' consists essentially of *Retropinna tasmanica* McCulloch, accompanied in varying numbers by *Galaxias attenuatus* (Jenyns) and *Atherina spp.* It is evident that either the composition of the shoals is subject to remarkable variation, or else, more probably, at least two distinct migrations are being confused.

An examination of numerous examples confirms the statement by McCulloch (1915, p. 260) that the maxillary extends only to the level of the anterior fourth or third, and not, as described by Johnston, to below the middle, of the eye.

Family ECHELIDAE

Genus **Muraenichthys** Bleeker, 1865

Muraenichthys australis Macleay

Muraenichthys australis Macleay, *Proc. Linn. Soc. N.S.W.* VI. 2. 1881. p. 272.
Scolenchelys australis Ogilby, *Proc. Linn. Soc. N.S.W.* XXII. 2. 1897. p. 246.

Record. A specimen from Northern Tasmania in the Museum collection (Reg. No. FR 947) appears clearly to be referable to this species. The origin of the dorsal is shortly behind that of the anal, as noted by McCulloch (1911, p. 20) in his re-examination of the holotype in the Macleay Museum, and not over the vent, as stated in Macleay's original description.

Proportions. The principal proportions of the specimen are recorded for comparison with those of the holotype as given by McCulloch. Depth of body behind gill opening (5·8 mm.) 3·9, behind vent (5·5) 4·1, in head (22·5). Head 12·1 in total length (272), 4·1 in trunk (91·5). Eye (1·2) 3·5 in snout (4·25), which is 5·0 in head. Mouth-cleft (8) 2·6 in head. Length to vent (114) 1·39 in tail (158). Length to origin of anal (116) 1·01 in length to origin of dorsal (117).

Remarks. First record for Tasmania. The species has previously been recorded only from New South Wales.

Genus **Ophiclinus** Castelnau, 1872

Ophiclinus greeni, sp. nov.

(Text-fig. 1)

D. xlix, 1 [xlix, 1]. A. iii, 31 [iii, 31-32]. P. 11 (left fin), 12 (right fin) [11-12]. V. 2 [2]. C. $13 + \substack{1 \\ 1}$ [$13 + \substack{1 \\ 1}$].

Depth 7·6 [7·1-8·2] in total length, 6·9 [6·4-7·5] in standard length; depth at level of first anal ray 7·8 [7·7-8·9] in total length, 7·1 [6·9-8·1] in standard length. Head 5·7 [4·9-5·4] in total length, 5·2 [4·4-5·0] in standard length. Eye 5·5 [5·3-6·1] in head, 1·5 [1·2-1·4] in snout, 1·2 [1·1] times interocular distance. Head and trunk 1·2 [1·1-1·2] in tail without caudal fin.

Body elongate, compressed, covered with small non-imbricating scales, somewhat more closely set posteriorly (not shown in figure). Head subconical; naked, as also is nape. Eye moderate, not cutting superior profile; interorbital space convex. Lower jaw projecting slightly beyond upper; maxillary extending to [or slightly beyond] level of middle of eye. Anterior nostril tubular, higher than wide, surmounted posteriorly by a short blunt tentacle; inserted at about the position of two (or ten) o'clock relative to the eye, rather nearer upper lip than orbit; its distance from its fellow 1·8 [2·0] in length of snout. Posterior nostril a simple opening close to orbit, at about the position of one o'clock.

Lateral teeth in upper jaw small, uniserial or biserial, the row or rows widening anteriorly to form a very broad patch, among which are larger teeth. Mandibulary teeth in a fairly broad band anteriorly, becoming uniserial laterally. Vomerine teeth acute, fairly large, in a uniserial or biserial proconvex arc.

Fairly large pores on dorsal surface of snout, between eyes, encircling eye, fringing preoperculum, on mandible, on superolateral and dorsal surfaces of postorbital portion of head. Lateral line short, comprising about 15 pores; very slightly arched, its origin and termination at about the same horizontal level; originating just above base of opercular flap, at level of 2nd dorsal spine; terminating at about lèvel of 10th dorsal spine.

Dorsal fin originating about midway between levels of preopercular and opercular margins; length to its origin 1·1 [1·1] in head; joined to proximal third of caudal; 1st spine 5·2 [5·7-6·0], 25th spine 3·1 [3·6-3·9], the single ray 2·8 [3·0-3·4], in head. Anal fin originating below 20th [19th-20th] dorsal spine; length to its origin 2·2 [2·1-2·2] in standard length; joined to proximal third of caudal; 2nd spine 6·0 [7·2--7·7], 16th ray 2·9 [3·0-3·7], in head. Pectoral fin rounded; all rays simple; extending 0·5 [0·4-0·5] of distance between its origin and vent; longest (6th) [6th-7th] ray 1·7 [1·7-1·9] in head. Pelvic fins contiguous basally; length to their origin 1·2 [1·2-1·3] in head; longer (inner and hinder) ray 1·4 [1·6-1·8] in head. Caudal fin truncate, feebly rounded; all rays simple; 1·9 [2·0-2·1] in head, 9·8 [8·8-10·6] in standard length.

General colour dark brown, approaching black, above, greyish brown, or pale brown, below. On the body the essential features of the colour-pattern are: first, a broad dark region bounded inferiorly by a line running from a little below the upper angle of the operculum to near the middle of the caudal base; secondly, below this, a slighter broader region, which, in advance of the vent, is much lighter in colour than, and very sharply delimited from, the first region, but which, behind the vent, progressively darkens, and ultimately becomes more or less assimilated with the upper region, there always being left, however, several small islands of light ground colour between the partial fusion of the two regions posteriorly. The intensity and extent of the darkish region above the anal base vary considerably. In the larger paratype a narrow yellowish streak immediately underlies the dark upper region of the sides, and the distal islands are a discrete backward extension of this, rather than of the brownish of the general lower region: a similar state of affairs obtains, in a much less marked degree, in the holotype. In the anterior half or third of its length the dorsal base is narrowly bordered on each side with yellowish; further back there appear a few discontinuous indications of the extension caudad of this stripe. A longitudinal band, either wholly blackish or dark brown margined with blackish, runs from tip of snout, just embracing eye, to operculum, where its inferior margin becomes confluent, without change of direction, with the lower border of dark region of sides of body, and its superior margin rises to join the upper border of the same region where it bounds the yellowish streak at base of dorsal. Anteriorly this band embraces the upper third of both upper and lower lips, which, being elsewhere greenish, immaculate, are thus conspicuously bicolor. Dorsal surface of head brownish; ventral and lateral aspects concolorous with corresponding light-coloured aspects of body, and, like them, minutely punctulate with brownish. Dorsal fin brownish, with narrow distal band of white; the dark brown of the sides continued up on to the fin in a variable number of blotches, most extensive, most closely set, and darkest posteriorly. Anal fin similar to dorsal, but with rather wider white border. Pectoral fin white. Pelvic fin greyish; in one paratype pale pinkish brown.

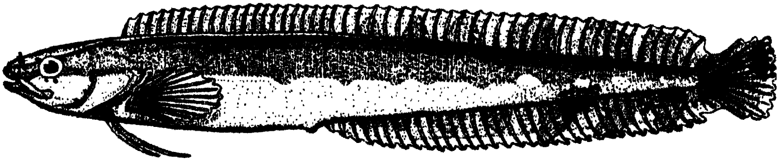

Fig. 1.—*Ophiclinus greeni*, sp. nov. Holotype. Low Head, Tasmania. Total length 44·6 mm. [The small non-imbricate scales are not shown.]

Life-colours, as noted by collector. 'Dorsal fin light with dark continuations of body-colour. Lower portion [of body] light pinkish colour. Pectoral fins tipped with pink.'

Total length 44·6 mm. [34·3-49·8 mm.]; standard length 40·5 mm. [31·9-45·5 mm.].

Specific name in honour of Mr. G. R. F. Green, collector of the specimens described, whose interest in rock-pool fauna has enriched the Museum collections with much interesting ichthyological and invertebrate material.

Types. Described and figured from the holotype (Text-fig. 1) and from two paratypes, the numerical characters of the latter being recorded throughout in square brackets. Holotype in the Queen Victoria Museum, Launceston (Reg. No. HT 805). Paratypes will be offered to the British Museum (Natural History), London, and Australian Institute of Anatomy, Canberra.

Locality. Lady Lucy Beach, Low Head, Northern Tasmania; 17th January, 1934, and 3rd June, 1934.

Affinities. *Ophiclinus greeni* belongs to the group of species (*O. gracilis* Waite, and *O. gabrieli* Waite) comprised under the heading 'Vomerine teeth pointed, forming an angular row or series' in the key by McCulloch and Waite (1918, p. 55). It may readily be distinguished from *O. microchirus* (Herzenstein) and *O. homocanthus* (Herzenstein), which are not noted in the key by McCulloch and Waite, and for copies of the descriptions of which I am indebted to the courtesy of Mr. G. P. Whitley, Ichthyologist, Australian Museum, Sydney, by its decidedly fewer dorsal and anal rays (*O. microchirus* has D. 90, A. 56; *O. homocanthus*, D. 56-60, A. 40-42).

It finds its nearest ally in *O. gracilis* Waite, which in general appearance and coloration it very closely approaches, and from which it is chiefly distinguished by the following characters: consistently greater number of dorsal spines and anal rays; rather fewer pectoral rays; origin of anal below about 20th, instead of 17th, dorsal spine; lateral line nearly straight, not, or scarcely, continued obliquely downwards posteriorly. From *O. gabrieli* Waite, which it approaches in the formulae of the vertical fins, and in the course of the lateral line, it is readily separable by the more anterior origin, and greater evenness of height anteriorly, of the dorsal fin; larger pectoral; less rounded caudal; coloration. In the legend to Waite's plate (1906, pl. XXXVI) accompanying the original descriptions of *O. gracilis* and *O. gabrieli* the names of the two species are transposed.

Remarks. First record of the family Ophiclinidae from Tasmania.

Family OPHIDIIDAE

Genus Genypterus Philippi, 1857

Genypterus blacodes (Bloch and Schneider)

Ophidium blacodes Bloch and Schneider, *Syst. Ichth.* 1801. p. 484.
Genypterus blacodes McCulloch, *Aust. Mus. Mem.* V. III. 1929. p. 357 (references and synonymy).

Variation. A specimen, 402 mm. in total length, caught near George Town, on or about 20th March, 1934 (Reg. No. 832), exhibits an interesting, and (at least in Tasmanian examples) apparently rare, variation in colour-pattern. Instead of being whitish, immaculate, the preanal ventral region is somewhat bluish green, faintly tinged with pale brown, and is conspicuously mottled with the dark vandyck brown of the ordinary lateral blotches. The mottlings, of which there are about 150, are longest longitudinally: they vary in form from elliptical to linear, and in size from about 2 mm. to about 15 mm. The chin, which is normally white, and immaculate, save that a small patch of punctulations is often present at about the level of the hinder end of the maxillary, is here minutely but thickly dotted throughout with brown. The specimen exhibits no deviation from the normal in structure or proportions.

Distribution. This appears to be the common species of Northern Tasmania, practically all the locally obtained ling retailed in Launceston fish-shops being this form. On the other hand, supplies received in Launceston from Strahan consist almost exclusively of *Genypterus microstomus* Regan.

Family GOBIESOCIDAE

Remarks. In spite of its small size, the Australian group of Gobiesocidae has been dogged by confusion, which has followed it not only along the seemingly inescapable highway of nomenclatural misapprehension, but also even into the byways of trivial error in orthography and the notation of illustrations. Whitley (1931) has recently defined more clearly the relationships of several species, both to one another, and to extralimital forms. The whole group, however, appears to be in need of anatomical and osteological revision: accordingly, in the arbitrary key given below generic affinities as customarily recognised are expressly disregarded, and emphasis is placed on characters that, though of minor taxonomic significance, afford practical criteria for ready determination.

Reduced to the simplest terms by the omission of purely formal and derivative references, the histories of the six Australian members of the family, considered in historical sequence, are as follow:

(*a*) *Aspasmogaster tasmaniensis* (Günther). Original description (1861, p. 507), as logotype of *Crepidogaster*, based on a single individual, 26 lines in total length, presented to the British Museum by Ronald Gunn; not figured. McCulloch (1922, p. 122) notes a record by Kner (1867, p. 277) from Sydney, but regards it as an error, and in the Check-List (1929, p. 359) gives New South Wales as a queried locality. Waite, who had already (1906, p. 201) discussed, under the generic name *Crepidogaster*, the species next to be mentioned, later (1907, p. 315) called attention to the fact that *Crepidogaster* Günther, 1861, was preoccupied by *Crepidogaster* Boheman, 1848 (Coleoptera), and put forward the *nom nov.*, *Aspasmogaster*—afterwards, *fide* McCulloch (1929, p. 359), spelt *Aspasmagaster* by Jordon in *Genera of Fishes.* Included by Waite (1923) in his last South Australian catalogue. The species, which is not the subject of recent description in literature available to me, is redescribed and figured below.

(*b*) *Aspasmogaster spatula* (Günther). Original description (1861, p. 508) based on a single specimen, 21 lines in total length, from Gages Road, Swan River, Western Australia; not figured. Described in detail (p. 201), and figured by Waite (1906), who gives Victorian records. Waite's text correctly refers to his pl. XXXVI, fig. 4, but the legend to the plate gives fig. 2 as *A. spatula*, fig. 2 actually being *V. cardinalis*. Generic history as in (*a*).

(*c*) *Volgiolus cardinalis* (Ramsay). Günther (1861, p. 506) established *Diplocrepis*, with *Lepadogaster puniceus* Richardson, from New Zealand, as haplotype, and Ramsay's Gobiesocid from near George Town, Tasmania, originally described (1882, p. 148) as *Gobiesox cardinalis*, has been referred to Günther's genus by Waite and Australian authors generally. Detailed description (p. 204) and figure (pl. XXXVI, fig. 2) by Waite (1906), based on three specimens from near Launceston, and three from Ulverstone, forwarded from this Museum in 1903. Waite's text cites pl. XXXVI, fig. 1, but fig. 1 is a Symbranchid; the legend to the plate, on the other hand, gives *V. cardinalis* as fig. 4, but actually fig. 4 is *A. spatula*, the figure of *V. cardinalis* being that numbered 2 on the plate. Included in synopsis of species of *Diplocrepis* by Waite (1906, p. 205). Whitley (1931, p. 325) considers that the Australian species hitherto relegated to *Diplocrepis* are not congeneric with *Lepadogaster puniceus* Richardson, and has proposed *Parvicrepis* for *D. parvipinnis* Waite, with *Volgiolus* as a subgenus having as orthotype *D. costatus* Ogilby, and apparently including also *G. cardinalis* Ramsay. More recently (1935, p. 292), in giving illustrations of the adhesive apparatus, he elevates the two species last mentioned to separate generic status as *Volgiolus costatus* and *V. cardinalis*, respectively. Life-colours of present species, apparently hitherto unrecorded, described below.

(*d*) *Volgiolus costatus* (Ogilby). The first reference to the species (1885, p. iii) is a *nom. nud.*, the description (1885, p. 270) being made available some five weeks later; not figured. Type-locality: Shark Reef, Port Jackson, N.S.W. Since recorded, *fide* McCulloch (1929, p. 360), from South Australia, Victoria, Lord Howe Island, New Caledonia. Figure (fish) by Waite (1904, pl. XXIV, fig. 1); inclusion in synopsis of species of *Diplocrepis* by Waite (1906, p. 205); variation in radial formulae by McCulloch and Waite (1918, p. 66); generic history as in (*c*); figure (ventral aspect of head and trunk) by Whitley (1935, p. 292).

(*e*) *Parvicrepis parvipinnis* (Waite). Original description (1906, p. 202),, with figure (pl. XXXVI, fig. 3), and inclusion in synopsis of species of *Diplocrepis* (p. 205); New South Wales. For generic history, see (*c*).

(*f*) *Lepadichthys frenatus* Waite. Originally described (1904, p. 180) and figured (pl. XXIV, fig. 2) from two specimens from Lord Howe Island; since recorded also from Queensland.

KEY TO THE AUSTRALIAN GOBIESOCIDAE.

A. Dorsal fin not connected by membrane with base of caudal fin
  B. Horizontal distance between termination of dorsal and base of median caudal rays much greater than (nearly twice) total base of dorsal .... *Parvicrepis parvipinnis*
  BB. Horizontal distance between termination of dorsal and base of median caudal rays much less than (about one-third of) total base of dorsal:
    C. Vent much nearer to anal fin than to adhesive apparatus. Anal origin slightly behind dorsal origin ... *Volgiolus costatus*
    CC. Vent rather nearer to adhesive apparatus than to anal fin. Anal origin about below middle of dorsal base .... *Volgiolus cardinalis*
  BBB. Horizontal distance between termination of dorsal and base of median caudal rays rather less than (about two-thirds of) total base of dorsal .... *Aspasmogaster spatula*
AA. Dorsal fin connected by membrane with base of caudal fin
    D. Dorsal with about 16 rays; its base about equal to length of head. Anal joined by membrane to caudal .... *Lepadichthys frenatus*
    DD. Dorsal with 8-10 rays; its base about half length of head. Anal not joined by membranes to caudal .... *Aspasmogaster tasmaniensis*

Genus **Aspasmogaster** Waite, 1907

Aspasmogaster tasmaniensis (Günther)

(Text-fig. 2)

Crepidogaster tasmaniensis Günther, *Cat. Fish. Brit. Mus.* III. 1861, p. 507.
Aspasmogaster tasmaniensis Waite, *Rec. Aust. Mus.* VI. 4. 1907, p. 315.

$$\text{B. 5. D. 8-10. A. 7-9. V. I, 4. P. 23-24. C. } 12 + \frac{c.\ 2-3}{c.\ 3-4}.$$

Length of head 2·9-3·1, width of head 4·1-4·4, depth of body 6·2-8·4, width of body 5·6-6·5, in total length. Snout 3·3-4·1 in head, 10·0-12·0 in total length. Eye 4·1-5·1 in head, 1·1-1·3 in interorbital width.

Body subcylindrical anteriorly, somewhat compressed posteriorly. Head much depressed; moderately broad; its width subequal to distance from anterior margin of eye to origin of pectoral. Snout narrow, beak-like, greatly depressed, its tip (excluding upper lip) about on a horizontal level with inferior margin of pupil, its dorsal surface concave. Nearly half the dorsal profile in advance of eye formed by the large, completely reflexed upper lip. Upper jaw projecting beyond lower. Lower lips meeting at symphysis, immediately behind which they are markedly inflated inwardly and downwardly. Mouth extending to below anterior ⅕ or ⅓ of eye. Teeth in upper jaw small, villiform; in a large patch of 5 or 6 rows in front, in one or two series behind. Teeth in lower jaw similarly disposed, but rather larger, especially laterally. Anterior nostril tubular; slightly in advance of orbit, at about level of middle of eye; its distance from its fellow subequal to its distance behind tip of snout, excluding upper lip; about as wide as high, surmounted by a bluntly bilobed process, whose length slightly exceeds distance between anterior and posterior nostril. Posterior nostril tubular; placed hard against eye, at position (left aspect) of ten o'clock; about as wide as high. Eye large, subcircular, tumid, cutting dorsal profile. Interorbital space flat, or slightly concave. No subcutaneous spine on operculum or preoperculum. Gill-membranes united across isthmus, shortly in advance of anterior adhesive disk.

Dorsal fin rather long and low; inserted far back, its last ray joined to caudal by membrane; length to its origin 1·5 in total length, 1·3-1·4 in standard length; base 1·5-1·6 in head, subequal to distance between anterior margin of sucker and tip of lower lip; median rays subequal to snout. Anal fin similar in form to, but shorter than, dorsal; originating about below 2nd dorsal ray; terminating below interspace between origin of last dorsal ray and point of attachment of membrane joining it to caudal; last ray obscurely joined to caudal peduncle by membrane; base 1·2 in that of dorsal. Pectoral fin broad, rounded; its longest (about 10th) ray 2·6-2·9 in head; its length subequal to that of posterior adhesive disk, at, or just beyond, the level of which the fin terminates. Pelvics attached to 16th-17th pectoral ray; their crenulated common anterior border free, extending to within about an eye-diameter of posterior margin of eye; their free tips extending to level of middle of posterior sucker, or slightly beyond. Caudal fin moderate, rounded; length 2·3 in head, rather less than anal base.

Anterior adhesive apparatus about as wide as body at level of pectoral origin; its inner gelatinous region subcircular, the slightly truncated posterior margin just overlapped by free anterior border of second sucker. Posterior adhesive apparatus transversely elliptical; its width, which is almost as great as that of the body at this point, nearly one and one-third times its length, which is subequal to its distance from vent, or about half width of head; its inner gelatinous region comprising an anterior subrectangular portion followed by about three-fourths of an ellipse, the transverse major axis of which is rather less than diameter of gelatinous disk of first sucker; distance of free posterior margin of whole apparatus from vent 1·3-1·6 times distance of vent from origin of anal fin.

The colour in life was noted by the collector, Mr. G. R. F. Green, as 'Dark green with brown markings when found; but when placed in a white net turned light green'. Examined shortly after their preservation in formalin, the specimens exhibited a striking colour-pattern, comprising some fourteen vertical dark bars, which, except for the bar overlapped by the adpressed pectoral, which is twice as wide as its neighbours, are subequal in width to the interspaces of lighter ground colour. After long preservation in formalin they become a uniform dingy, very pale, pinkish yellow.

Material examined. Described from three specimens, 53, 53, 36 mm. in total length, or 46, 46, 30·75 mm., respectively, in standard length. (Reg. Nos. 903 *a-c.*) One of the larger individuals figured (Text-fig. 2).

Locality. In rocky pools, Lady Lucy Beach, Low Head, Northern Tasmania; Mr. G. R. F. Green; 4th March, 1934.

Remarks. The specimens agree reasonably well with Günther's description, the most important point of divergence being that Günther observes, 'caudal fin quite free from dorsal and anal', whereas in the present examples the dorsal is connected by membrane with the base of the caudal. The connection is, however, barely made, being decidedly less extensive, for instance, than that in *Lepadichthys frenatus* Waite (in which form the anal also is joined to the caudal): it seems probable that the connecting membrane could easily be destroyed as the result of a slight injury. The remaining characters of the present examples, including the peculiar narrow snout, are so generally conformable to the description of *A. tasmaniensis* as to leave little doubt the specimens are really referable to this species.

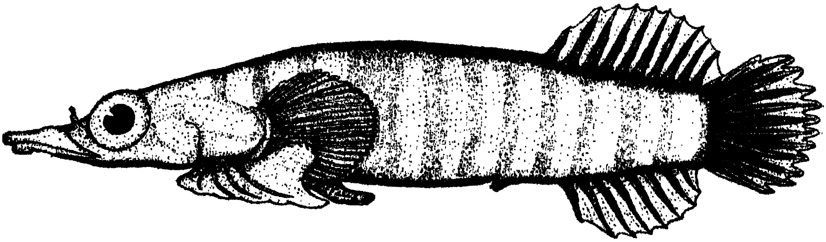

Fig. 2.—*Aspasmogaster tasmaniensis* (Günther). A specimen from Low Head, Tasmania. (× 2.)

Affinities. A. tasmaniensis is distinguishable at sight from the only other Australian member of the genus, *A. spatula* Günther, recorded from Victoria and Western Australia, by the much more posterior insertion of, longer bases of, and inequality between, its dorsal and anal fins, and by its narrow snout. The produced snout and the union of dorsal and caudal serve also to distinguish the present form from the two New Zealand species—*A. hectoris* (Günther), type-locality southern shore of Cook's Strait, having the 'caudal peduncle slender, longer than the caudal fin' (1876, p. 396), and *A. simus* (Hutton), described from Lyttleton Harbour and Chatham Islands, having the 'distance from the end of the dorsal, or anal, to the caudal very short, about one-fifth of the length of the caudal, or one-third of the least depth of the tail' (1896, p. 316).

Genus **Volgiolus** Whitley, 1935

Volgiolus cardinalis (Ramsay)

Gobiesox cardinalis Ramsay, *Proc. Linn. Soc. N.S.W.* VII. 2. 1882. p. 148.
Volgiolus cardinalis Whitley, *Aust. Mus. Mag.* V. 9. 1935. p. 292 (text-fig.).

Occurrence. At George Town and Low Head—the type-locality is 'near George Town'—this species is quite a common constituent of the intertidal rock-pool fauna. I have met with it also at Ulverstone—from which locality, as mentioned above, specimens examined by Waite were obtained—but have not noted it as being at all common there.

Colour. While the specific name *cardinalis* clearly indicates the colour of Ramsay's material, Waite says of his specimens, 'In fluid all examples are uniformly yellow'. In my experience the colour depends on the medium of preservation. Specimens in alcohol become bright red (occasionally slightly mottled with yellow) everywhere save on the preanal ventral surface, which turns yellow, the fins assuming the colour of the body in the vicinity: examples preserved in formalin become throughout, including fins, a dull pale yellow, occasionally exhibiting a faint purplish tinge.

Waite (1906) observed that the life-colours are not known, a state of ignorance apparently still unremedied. Notes on the colours of a fresh topotypical specimen, 37 mm. in total length, collected by Mr. G. R. F. Green, on 22nd January, 1934, are given below.

General ground colour pale translucent green; ventral surface white with a tinge of green, except on tail, which is concolorous with sides and back. Dorsal surface, which behind the head exhibits a distinct purplish suffusion underlying the green, abundantly punctulated throughout, and spotted and marbled with dark greenish. Sides marked in posterior half with spots, lighter than the ground colour, that tend to form two or three longitudinal rows, those of the lowest row the largest. Three or four obscure dark green vertical bands on the body, about as wide as their interspaces, extending about halfway down the sides. Head in general concolorous with body. Purple lozenge on nape. Purplish tinge on dorsal surface of snout, with definite narial spots of purple. Extending downwards and forwards from antero-inferior border of eye a clear unpunctulated region of pale green, subtriangular, widest inferiorly, bounded behind by a well-defined subvertical dark green band. Iris green; dark blue pupil with narrow annulus of dark orange. Ventral surface in advance of sucker in general immaculate, though the punctulations of the sides extend slightly beyond inferior profile of body, and there are also present two forwardly converging bands of punctulations visible only with a lens; behind sucker with the smaller, but without the larger, spots of sides and back. Adhesive apparatus immaculate, whitish, becoming pinkish centrally. Vertical fins more or less greenish, the dorsal with a purplish spot in its upper anterior half, the anal with some purplish, especially near its middle, the caudal with a vertical band of purplish distally. Pectorals greenish, thickly punctulated with darker. Pelvics white, with a hint of green distally; a few small dark spots, mostly placed proximally.

A second specimen, 25 mm. in total length, collected at the same time, is generally similar in coloration, but exhibits the following variations: caudal with three vertical bars of purplish, the anterior one extending on to the caudal peduncle; dorsal and anal fins, when depressed, are seen to be crossed by distinct brownish purple bands, three on dorsal, two on anal; purplish tinge on dorsal surface of body more decided, and extending further caudad; purple lozenge on nape less conspicuous; clear triangular suborbital region less clearly defined, being to some extent encroached on by punctulations.

Family PATAECIDAE

Genus **Pataecus** Richardson, 1844

Subgenus **Pataecus,** nov.

Diagnosis. Antero-dorsal profile of snout inclined forward. No verrucae. Dorsal spines and anal rays not noticeably buried.

Orthotype. Pataecus fronto Richardson = *Pataecus (Pataecus) fronto* Richardson.

Pataecus fronto Richardson, *Ann. Mag. Nat. Hist.* XIV, 91. 1844. p. 280.
Pataecus subocellatus Günther, *Proc. Zool. Soc. London.* 1871 (1872). p. 665. pl. lxiv.

Scope and Distribution. The subgenus includes only the orthotype; Western Australia, South Australia, New South Wales, Queensland.

Remarks. In the course of supplying some data on Pataecid material in the Australian Museum, Sydney, Mr. G. P. Whitley, Ichthyologist, has called my attention to the isolated position occupied by *P. fronto*, and has suggested the present discussion of the Tasmanian members of the genus might provide a convenient occasion for recognizing this by generic or subgeneric distinction: the proposal here made for the establishment of two subgenera of *Pataecus* is the outcome of Mr. Whitley's courteous suggestion.

Subgenus **Aetapcus** nov.

Diagnosis. Antero-dorsal profile of snout inclined backward. Regularly arranged verrucae on head and body. Dorsal spines and anal rays more or less buried and hidden in fleshy membrane.

Orthotype. Pataecus maculatus Günther = *Pataecus (Aetapcus) maculatus* Günther.

Pataecus maculatus Günther, *Cat. Fish. Brit. Mus.* III. 1861. p. 292.

Scope and Distribution. The subgenus comprises *P. (A.) maculatus* Günther, Western Australia, South Australia, Tasmania; *P. (A.) vincenti* Steindachner, South Australia; *P. (A.) armatus* Johnston, Tasmania.

Aetapcus, an anagram of *Pataecus.*

Pataecus (Aetapcus) armatus Johnston

(Text-fig. 3)

Pataecus armatus Johnston, *Pap. Roy. Soc. Tasm.* 1890 (1891). p. 33. *Lapsus calami.*

Pataecus maculatus Waite, *Rec. Aust. Mus.* VI. 2. 1905. p. 76 (but not Waite's actual specimen from Tasmania, nor his figure—pl. XV.—of a specimen from Fremantle, both of which = *P. maculatus* Günther). *Id.* Waite, *Rec. S. Aust. Mus.* II. 1. 1921. p. 169 (Tasmanian reference only; not fig. 276). *Id.* Lord, *Pap. Roy. Soc. Tasm.* 1922 (1923). p. 71. *Id.* Lord and Scott, *Synopsis Vert. Anim. Tas.* 1924. p. 86. Not *P. maculatus* Günther, *Cat. Fish. Brit. Mus.* III. 1861. p. 292.

Pataecus maculatus var. *armatus* Whitley, *Pap. Roy. Soc. Tasm.* 1928 (1929). p. 64. *Ex* Johnston MS.

Pataecus armatus McCulloch, *Aust. Mus. Mem.* v. III. 1929. p. 398.

D. 34. A. 10. P. 8. C. 12. (The upper two rays are imperfectly developed, failing to reach the free margin of the membrane; their presence is perhaps an individual peculiarity). Gill-rakers on lower limb of anterior arch 12, low, mammilloid, denticulate.

Depth of body (41 mm.) equal to length of head (41), or 3·0 in total length (121), 2·5 in standard length (103). Eye, including rim, (4) 10·3, snout (10) 4·1, maximum depth of head (38) 1·1, depth of head at level of eye (31) 1·3, interorbital width (5) 8·2, in length of head. Length to vent (*c.* 65) *c.* 1·9 in total length.

General form similar to that of *P. (A.) maculatus* Günther. Eye with a raised rim, lying in a concavity; about equidistant from anterior and superior profiles and about two and a half times as far from ventral profile. Posterior nostril in a concavity; tubular, as wide as high; about an eye-diameter in advance of, and about half an eye-diameter below, eye. Anterior nostril apparently a simple aperture, an eye-diameter below, and slightly in advance of, posterior nostril. Cleft of mouth oblique; its horizontal length subequal to its distance from base of first dorsal spine; jaws equal anteriorly. Maxillary extending slightly behind level of eye; the width of its expanded hinder end half its distance from eye. Teeth in lower jaw villiform, forming in each ramus a well-defined band, anteriorly with five or six somewhat irregular rows, narrowing posteriorly to a single row; bands nearly meeting at symphysis, their nearest approach being in their outer half. Teeth in upper jaw similar in form and disposition, but bands less closely approximated mesially. A small semilunar patch of villiform teeth on vomer.

General surface of skin smooth. Low verrucae and lateral ridge present, disposed more or less as in *P. (A.) maculatus.* A series of tubercles, one at the base of each ray, along the whole dorsal profile.

Dorsal fin with 22 rays spinous; originating at level of upper border of eye, well in advance of eye, the 3rd spine being above the anterior ocular margin; connected posteriorly by membrane to outer third of first complete caudal ray; 1st, 2nd (stoutest), 3rd, 11th, 22nd spines 3·5, 1·9, 1·8, 3·0, 2·6, respectively, in head; 1st, 9th (longest), 12th soft rays 2·6, 2·0, 2·2, respectively, in head; the anterior spines partly concealed in membrane, other spines and rays readily observable. Anal fin originating below 21st dorsal spine; terminating rather less than an eye-diameter in advance of level of base of median caudal rays; its base 1·5 in head, subequal to direct distance between pectoral origin and eye; its vertical height half the length of its longest (median) ray, which is 4·1 in head; all rays more or less concealed in thick membrane. Pectoral fin deeply excavate interradially; rays fairly patent, simple, the longest (3rd) 1·3 in head. Caudal fin rounded, obliquely truncated inferiorly; 2·3 in head; rays simple, the upper rather more slender than the lower.

Ground colour (in formalin) whitish, abundantly punctulated with rufous brown, the net effect being a pale greyish brown, with a distinct reddish tinge, varying in intensity in accordance with the number of punctulations, being most marked on the head, much less marked in the region covered by the pectoral in its normal, upwardly oblique position, and scarcely observable on the throat. Except the region immediately behind the opercle, which is irregularly mottled with brownish, the sides bear a number of reddish brown spots of variable size, showing some tendency to form four or five longitudinal series, each of about a dozen; two rather large isolated spots near the dorsal profile, one shortly behind the level of the operculum, the other at about the level of the anal origin. Ventral surface of body, except throat, with numerous subcircular rufous spots. Head with a number of more or less irregularly disposed subcircular rufous spots, most numerous below the level of the eye. About ten spoke-like markings radiating from eye, those at positions of ten and four o'clock (from left aspect) more conspicuous than the rest.

Dorsal fin greyish, spotted with reddish brown; largest spots tending to form half a dozen short arcs above the head, behind which they form a single row in basal half of fin, this row being surmounted by a subparallel row of smaller, more numerous spots; a few greyish spots on non-spinous portion of fin; a number of small spots and punctulations irregularly scattered over most of fin. Anal fin pale greyish brown, lightly spotted and marbled with darker. Pectoral fin pale olivaceous, slenderly barred and mottled with whitish; tips of rays light grey. Caudal fin grey, faintly yellowish; a few dark blotches in proximal half; a broad oblique inframarginal band of black, scarcely continued to upper and lower margins of the fin.

Material examined. Described and figured (Text-fig. 3) from a specimen, 121 mm. in total length, 103 mm. in standard length, in the Queen Victoria Museum, Launceston (Reg. No. 891).

Locality. Northern Tasmania.

Affinities. The specimen here described differs from *P. (A.) maculatus* Günther chiefly in colour-pattern, in the smooth skin, and in having more dorsal and fewer anal rays. It is identified with

P. armatus mainly on the strength of the characteristic coloration, since Johnston notes his specimen as having D. 32; A. 12. There is, however, some confusion in Johnston's account, since, after giving these radial characters and correctly citing 'D. 31; A. 12' for the type-specimen of *P. (A.) maculatus* from Fremantle, he expresses the opinion that his specimen represents 'only a local variety which probably varies slightly in colour and in the number of dorsal *and anal* rays' (italics mine).

Remarks. Johnston's specimen has been lost, and no further examples appear to have been met with since. The species is here for the first time fully described and figured. The involved history of this species implicit in the synonymy set forth above is deserving of a few lines of elucidation. Waite first (1905, p. 76) correctly suspected that the '*Pataecus armatus* Günther' of Johnston's second list (1891, p. 33) was a straightout *lapsus calami* for *P. maculatus* Günther; and later (1921, p. 169) formally relegated the former to the synonymy of the latter. Lord (1923, p. 71), and Lord and Scott (1924, p. 86), included *P. maculatus* on their lists, relying, it seems, solely on Johnston's record, as interpreted by Waite (1921)[1]. Whitley (1929, p. 64), making available Johnston's original memo-

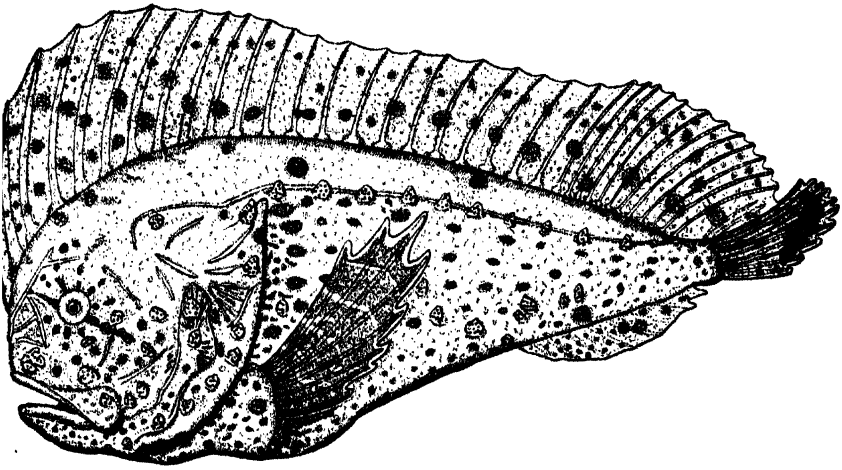

Fig. 3.—*Pataecus (Aetapcus) armatus* Johnston. A specimen from Northern Tasmania. Natural size.

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[1] The grounds of this opinion are: (*a*) absence of actual Tasmanian records in Lord and Scott; (*b*) inquiry shows no specimens were then available either in the Tasmanian Museum, Hobart, or the Queen Victoria Museum, Launceston; (*c*) internal evidence of the references cited by Lord and Scott. The real case for the recognition of *P. (A) maculatus* as a member of the Tasmanian fauna is discussed in the remarks on that species below.

randa, accepted a manuscript suggestion, and regarded Johnston's fish as a variety, *P. maculatus* Günther, var. *armatus* Johnston; while McCulloch (1929, p. 398) elevated it to full specific rank.

Pataecus (Aetapcus) maculatus Günther

Pataecus maculatus Günther, *Cat. Fish. Brit. Mus.* 111. 1861. p. 292. See also synonymy listed under *P. (A.) armatus* above.

Record. There is a specimen from Northern Tasmania (probably Tamar Heads) in the Museum collection (Reg. No. 890).

Pataecus (Aetapcus) maculatus Günther has at present no satisfactory standing in the Tasmanian list. It is not accredited to Tasmania by McCulloch in the Check-List; while reasons have already been given, in the course of the remarks on *P. (A.) armatus*, for considering it highly probable that the references to it in the lists of Lord, and Lord and Scott, really relate to *P. (A.) armatus.*

A Tasmanian specimen of a *Pataecus* was, however, referred by Waite (1905, p. 75), probably correctly, to this species. Waite's record was, I believe, overlooked by Lord and Scott; while McCulloch either overlooked it, or else, more probably, assumed the specimen to be referable to *P. (A.) armatus.*

Waite observes of his specimen that it differs from a topotypical example of *P. (A.) maculatus* 'by having thirty-three dorsal spines [*i.e.*, total rays] and especially in the length of the pectoral fin, which is longer than in the Western Australian fish, and almost as long as the head. The body also is relatively deeper; these slight variations may be of individual or local import only'. The present example shares the first two, but not the third, of these peculiarities; and in view of the interesting character of these variations, the principal proportions of the specimen here noted are recorded below, as a basis for future investigations. The radial formulae are: D. 33 (xx, 13); A. 12; P. 8; C. 9.

Proportions. Depth (66 mm.) 3·2, depth at origin of anal (33) 6·4 head (60) 3·5 in total length (211); or 2·8, 5·6, 3·1, respectively, in standard length (184). Eye (4) 4·3, interocular width (10) 1·7, in snout (17). Length to vent (131) 1·6 in total length. Longest (3rd) dorsal spine (30) 2·0, longest (9th) dorsal ray (31) 1·9, longest (10th) anal ray (24) 2·5, longest (3rd) pectoral ray (57) 1·1, longest (3rd) caudal ray (27) 2·2, in head.

SUMMARY

1. Some general observations are made on *Lovettia sealii* (Johnston) [whitebait-constituent], *Genypterus blacodes* (Bloch and Schneider) [colour-variation], family Gobiesocidae [key to Australian species], and *Volgiolus cardinalis* (Ramsay) [life-colours].

2. Little-known species described and figured are *Aspasmogaster tasmaniensis* (Günther), and *Pataecus armatus* Johnston.

3. The inclusion in the Tasmanian list of *Pataecus maculatus* Günther is confirmed.

4. *Pataecus* and *Aetapcus*, new subgenera of *Pataecus* Richardson, are diagnosed.

5. *Ophiclinus greeni*, sp. nov. (family Ophiclinidae) is described and figured.

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PAP & PROC. ROY. SOC. TASMANIA, 1935 (17TH AUGUST, 1936).

A new Mygalomorph Spider belonging to the Genus *Hexathele* Ausserer

By

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(Read 11th November, 1935.)

The genus *Hexathele* Ausserer (1871) contains only five known species. The genotype, *Hexathele hochstetteri* Auss., was collected in New Zealand by the Novara Expedition. Since then three other species have been recorded from that country, namely, *H. petreii* Goyen (1886), *H. huttoni* Hogg (1908), and *H. websteri* Hogg (1908). A fifth species, *H. montanus* Hickman, was recorded from Tasmania by me in 1926.

In referring to *H. hochstetteri* and *H. petreii*, Hogg (1901) remarks, 'Except a discrepancy in the eyes I can find no difference in the descriptions of these two species'. Goyen's description of the male of *H. petreii* is so brief and vague that it gives little help in establishing the identity of the species. His description of the female, however, is definite in regard to the dentition of the chelicerae and the structure of the tarsal claws. He states (1886) that the groove of the falces has a large number of teeth on each side, and that the inferior tarsal claw is 'much bent but without teeth'. In regard to *H. hochstetteri*, Ausserer (1871) remarks 'die Afterklaue ist mehrzahnig', and in his diagram shows the inferior tarsal claw of the first pair of legs as having three teeth. Hogg apparently overlooked these features until 1908, when he received further specimens of the genus from New Zealand, and was able to recognize as a new species *(H. huttoni)* a form which he had previously (1901) regarded as identical with the genotype.

Rainbow (1920, p. 85) has tentatively recorded *Hexathele hochstetteri* as occurring in Papua, but thinks it quite possible that 'the specimens may have accidentally found their way into the bottle of Papuan material'.

E. Simon (1888, p. 222) described a spider from Chili under the name of *Hexathele cinereo-pilosa*, but subsequently made it the genotype of a new genus, *Scotinoecus* (1892).

The present paper gives a synopsis of the species of *Hexathele*, followed by a description of a new species, *H. fentoni*, from Tasmania.

Family DIPLURIDAE

Genus **Hexathele** Ausserer, 1871

KEY TO THE FEMALES OF THE SPECIES OF HEXATHELE

1. **Inferior tarsal claw with teeth** **2**
   Inferior tarsal claw without teeth **3**
2. **Tarsi of first and second pairs of legs armed with spines. Cephalothorax black** .... ***H. montanus* Hickman**
   Tarsi of first and second pairs of legs devoid of spines. Cephalothorax red-brown .... ***H. hochstetteri* Ausserer**
3. **Both margins of cheliceral furrow with teeth** .... ***H. petreii* Goyen**
   Retromargin without teeth **4**
4. **Front median eyes once their diameter apart** .... ***H. websteri* Hogg**
   Front median eyes less than their diameter apart **5**
5. **Abdomen dark-grey without pattern** .... ***H. huttoni* Hogg**
   Abdomen yellow-brown with pronounced pattern .... ***H. fentoni*, sp. nov.**

Hexathele fentoni, sp. nov.

Male. Holotype.

	mm.
Total length (excluding chelicerae and spinnerets)	11·0
Length of cephalothorax	5·2
Breadth of cephalothorax	4·3
Length of abdomen	5·5
Breadth of adbomen	3·5

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
	mm.	mm.	mm.	mm.	mm.	mm.
Leg 1	4·3	2·2	3·0	3·4	2·4	15·3
2	3·9	2·0	2·9	3·6	2·4	14·8
3	3·5	1·7	2·3	3·6	2·4	13·5
4	4·7	2·0	3·2	4·2	2·4	16·5
Palpi	2·9	1·4	2·0	--	1·0	7·3

Width of first patella at 'knee' 0·840 mm. Tibial index 16·1.
Width of fourth patella at 'knee' 0·812 mm. Tibial index 15·6.

Carapace. Ovate, truncate in front. Rear margin slightly indented. Surface glabrous except for a median longitudinal row of black hairs extending from ocular tubercle to fovea. Lateral margins fringed with coarse black hairs. Radial grooves distinct. Thoracic fovea 3·2 mm. from front margin, very slightly recurved. Cephalic region moderately high. Clypeus equal to slightly more than half the diameter of AME. The articular membrane between the base of the chelicerae and the carapace is faintly marked with black patches.

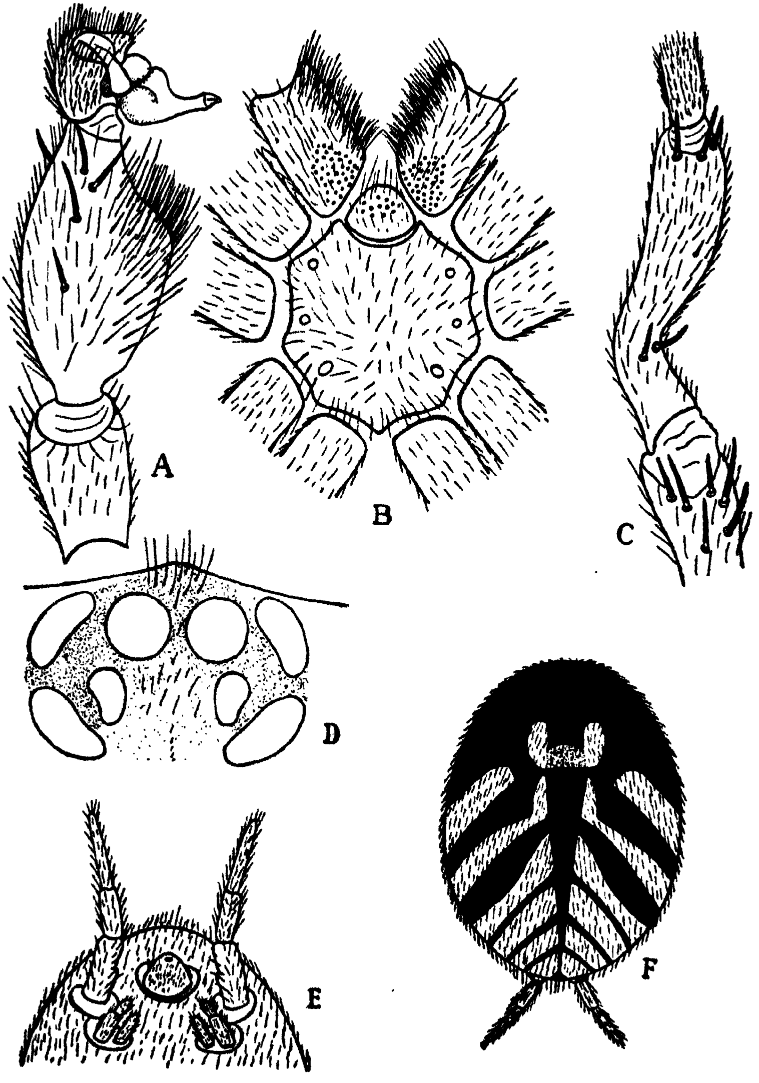

Fig. 1.—*Hexathele fentoni*, sp. n.

A.—Ventral view of left palpus of male. B.—Sternum, labium, and maxillae of male. C.—Ventral view of left metatarsus of first pair of legs of male. D.—Eye-group of male. E.—Spinnerets of male. F.—Dorsal view of abdomen of female, showing pattern.

Eyes. The eye-group is wider than long in ratio 19 : 11. Ocular tubercle pigmented with black between the eyes. In front of the eye-group are nine or ten stiff curved bristles. Anterior row of eyes straight by anterior edges; posterior row recurved. Ratio of eyes AME : ALE : PME : PLE = 5 : 6 : 3·5 : 6. AME are separated from each other by 2/5 of their diameter and from ALE by 1/5 of the diameter of the AME. The PME are separated from each other by 7/5 of the diameter of the AME. The laterals are separated by 2/5 of the diameter of the AME. (Text-fig. 1. D.)

Chelicerae. Basal segment 2·3 mm. long, dark-brown. Dorsal and retrolateral surfaces glabrous. Front and dorso-prolateral margin clothed with bristles. Rastellum absent. Fang 2·9 mm. long, slender, sharp, and curved. Promargin of furrow with nine large and three or four minute black teeth. Retromargin with a scopula, but without teeth.

Labium. Broader than long. Rounded in front. Clothed with long hairs and armed with 13 small cuspules. The groove separating the labium from the sternum is very shallow and dark-brown.

Maxillae. 1·7 mm. long by 1·0 wide. Provided with a scopula of fine red hairs and about 38 small cuspules on the basal third. (Text-fig. 1. B.)

Sternum. Light-brown, shield-shaped, longer than wide in ratio 40 : 38. Thinly clothed with coarse black bristles, and marked with three pairs of sigilla. The first and second pairs of sigilla are small and circular, the third pair larger and oval, separated from the margin by their length. (Text-fig. 1. B.)

Legs. 4. 1. 2. 3. Light-brown. Clothed with black hairs and bristles, but without a definite scopula. Trichobothria on all tarsi, metatarsi, and tibiae. Metatarsi of first pair of legs dark-brown and sinuous (Text-fig. 1. C). Tibiae normal. Upper tarsal claws with a row of 7 or 8 teeth crossing the claw obliquely. The inferior claw is small and devoid of teeth.

Palpi. Light-brown, clothed with black hairs and bristles. Genital bulb pyriform, ending in a short, twisted, lance-shaped style. Tibia dilated and furnished with numerous coarse bristles on the swollen part. (Text-fig. 1. A.)

Spines.—First leg. Femur: dorsal 1-1-1-1-1-1-1-1, prolateral 1-1, retrolateral 0, ventral 0. Patella: dorsal 0, prolateral 1-1, retrolateral 0, ventral 2-2. Tibia: dorsal 0, prolateral 1-1, retrolateral 0, ventral 2-1-2-1-3. Metatarsus: ventral 2-1-3, elsewhere 0. Tarsus: ventral 1-1, elsewhere 0. *Second leg.* Femur: dorsal 1-1-1-1-1-1-1, prolateral 1-1-1-1, retrolateral 1-1-1-1, ventral 0. Patella: dorsal 0, prolateral 1-1, retrolateral 0, ventral 2r. Tibia: dorsal 0, prolateral 1-1, retrolateral 0, ventral 1-2-1-2-3. Metatarsus: dorsal 1, ventral 2-1-2-1-4, elsewhere 0. Tarsus: dorsal 0, prolateral 1, retrolateral 1-1, ventral 0. *Third leg.* Femur: dorsal 2-2-2-2-2, prolateral 1-1, elsewhere 0. Patella: dorsal 0, prolateral 1-2, retrolateral 1-1, ventral

1r. Tibia: dorsal 1-1-1, prolateral 1-1-1-1-1, retrolateral 1-1-1, venttral 3-2-1-3. Metatarsus: dorsal 1, prolateral 1-1-1-1-1, retrolateral 1-1-1, ventral 2-2-1-3. Tarsus: dorsal 0, prolateral 1-1-1-1, retrolateral 1-1-1-1, ventral 1-1. *Fourth leg.* Femur: dorsal 2-1-1-1-1-1-1, elsewhere 0. Patella: ventral 1r, elsewhere 0. Tibia: dorsal 1 basal, prolateral 1-1, retrolateral 1-1-1, ventral 3-1-3-3. Metatarsus: dorsal 0, prolateral 1-1-1, retrolateral 1-1-1, ventral 2-1-1-2-1-1-4. Tarsus: dorsal 0, prolateral 1-1-1-1-1-1, retrolateral 1-1-1-1-1-1, ventral 1-1. *Palpus.* Femur: dorsal 1-1-1, elsewhere 0. Patella: prolateral 1, elsewhere 0. Tibia: retrolateral 1-1-2, elsewhere 0. Tarsus 0.

Abdomen. Brown. Clothed with black bristles anteriorly and dorsally. Sides and ventral surface clothed with fine black hairs. Dorsal surface marked with five pairs of dark oblique stripes and a median stripe as in the female. (Text-fig. 1. F.)

Spinnerets. Six. Yellowish-brown, clothed with black hairs. Posterior pair 3·5 mm. long, four-jointed above and three-jointed below, separated at the base by 1·5 mm. The other four spinnerets are in a straight line immediately in front of the posterior pair. The outer pair are two-jointed and 1·0 mm. long. The inner pair are one-jointed and 0·6 mm. long. The inner pair are separated from each other by 0·7 mm. Anal tubercle, yellowish, very large, and projecting between the posterior spinnerets. (Text-fig. 1. E.)

Female. Allotype.

	mm.
Total length (excluding chelicerae and spinnerets)	15·0
Length of cephalothorax	7·0
Breadth of cephalothorax	4·8
Length of abdomen	8·0
Breadth of abdomen	5·8

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
	mm.	mm.	mm.	mm.	mm.	mm.
Leg 1	4·6	2·3	2·8	2·8	2·0	14·5
2	3·9	2·2	2·4	2·6	1·8	12·9
3	3·4	1·8	1·8	2·5	1·7	11·2
4	4·6	2·3	2·8	3·1	1·7	14·5
Palpi	2·8	1·4	1·9	—	1·8	7·9

Width of first patella at 'knee' 0·986 mm. Tibial index 19.
Width of fourth patella at 'knee' 0·870 mm. Tibial index 17.

Carapace. Ovate, chestnut-brown. Front margin truncate, rear margin indented. Sides fringed with a few short hairs. Radial grooves distinct and slightly darker in colour than the rest of the carapace. Thoracic fovea deep and almost straight. Surface of carapace smooth and glabrous, except for a median row of black hairs extending from eye-group to fovea. Clypeus narrow. Articular membrane between the carapace and chelicerae suffused with black.

Eyes. Eye-tubercle moderately high. Eye-group wider than long in ratio 23 : 12. Space between the eyes black. A group of about twelve bristles in front of the eyes and a smaller group between the posterior median eyes. Anterior row of eyes straight by anterior edges, posterior row recurved. Ratio of eyes AME : ALE : PME : PLE = 6 : 7 : 4 : 6. AME separated from each other by half their diameter and from ALE by 1/6 their diameter. PME separated from each other by 11/4 of their long axis and from PLE by 1/4 of their long axis. Laterals separated by 2/7 of the long diameter of ALE.

Chelicerae. Basal joint 3·5 mm. long and almost black. The dorsal surface smooth and glabrous. Anterior surface clothed with black bristles. Rastellum absent. Promargin of furrow with a row of 12 teeth, of which the distal three are the smallest. Retromargin with a reddish scopula, but without teeth. A row of four minute teeth in the basal third of furrow. Fang long and well curved.

Labium. Convex, wider than long in ratio 23 : 15. Clothed with long fine bristles and armed with a group of 21 cuspules. Sternal suture procurved.

Maxillae. With parallel sides. Distal inner angle slightly produced. Scopula red. Surface clothed with bristles. A group of 29 cuspules on basal third.

Sternum. Width equal to length. Convex. Clothed with erect black bristles. Margin produced into blunt points between the coxae. Sigilla as in the male.

Legs. (1. 4.) 2. 3. Clothed with black bristles. True scopulae absent. Trichobothria on tibiae, metatarsi, and tarsi. Three tarsal claws. Superior claws with seven teeth. The inferior claw devoid of teeth. Palpal claw with six teeth.

Spines. First leg. Femur 0. Patella 0. Tibia: dorsal 0, prolateral 1, retrolateral 0, ventral 1-1-1-2. Metatarsus dorsal 0, prolateral 0, retrolateral 0, ventral 2-1-3. Tarsus: dorsal 0, prolateral 0, retrolateral 0, ventral 1r. *Second leg.* Femur 0. Patella: prolateral 1, elsewhere 0. Tibia: dorsal 0, prolateral 1, retrolateral 0, ventral 2-1-1-2. Metatarsus: dorsal 0, prolateral 1, retrolateral 0, ventral 2-2-4. Tarsus: ventral 1r, elsewhere 0. *Third leg.* Femur 0. Patella: prolateral 1-1, elsewhere 0. Tibia: dorsal 1-1, prolateral 2-3-2, retrolateral 1-1-1, ventral 2-2-2. Metatarsus: dorsal 2-2, prolateral 1-1-1-1, retrolateral 1 at apex, ventral 1-3-3-1-3. Tarsus: ventral 2-2, elsewhere 0. *Fourth leg.* Femur 0. Patella 0. Tibia: dorsal 0, prolateral 2-2-1, retrolateral 1d, ventral 2-2-2. Metatarsus: dorsal 2-2, prolateral 1, retrolateral 0, ventral 1-1-2-1-3. Tarsus: ventral 1-2-2-2-2, elsewhere 0. *Palpi.* Femur 0. Patella 0. Tibia: dorsal 0, prolateral 1-1-1, retrolateral 2-2-2, ventral 1. Tarsus: dorsal 0, prolateral 1-1-1-1-1, retrolateral 1-1-1-1, ventral 1.

Abdomen. Yellowish-brown. Clothed with black hairs. Dorsal surface marked with a median black stripe, which becomes narrower posteriorly. Six pairs of greyish-black oblique stripes on the sides. (Text-fig. 1. F.) Ventral surface yellowish-brown with a faint greyish median patch.

Spinnerets. Six. Posterior pair 4·3 mm. long, four-jointed on dorsal surface, three-jointed on ventral surface. The two anterior pairs are short and almost in the same transverse line, immediately in front of the posterior pair. The outer pair two-jointed, the inner pair one-jointed. The inner pair are separated from each other by 5/2 times their diameter.

Locality. National Park, Tasmania. (3450 feet.) 27th March, 1932.

Field Notes. Both male and female specimens were collected near the southern end of Lake Fenton. The spider makes a simple burrow, lined with silk, but not provided with a lid. The nests are fairly numerous in mossy banks among the deciduous Beeches *(Notofagus gunnii)* and Grass-trees *(Richea pandanifolia)* near the accommodation huts.

Type Specimens. The holotype male and allotype female have been placed in the Australian Museum, Sydney.

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Experiences of a Settler in the Early Days of Van Diemen's Land[1]

By

W. H. HUDSPETH, B.A.

(Read 8th April, 1935)

The Reverend John West, author of *The History of Tasmania*, writing in 1852, made these observations (p. 66):

> 'The landing of settlers, direct from Great Britain, was an important event: their efforts were experiments, and their achievements were prophetic. The political philosopher may trace, in their errors, trials, and successes, the lessons afforded by experience for the instruction of nations. The rapid advance of civilization tends to underrate the first efforts of our predecessors. The first colonial boatbuilder founded a great commercial navy: the first shepherd held in his slender flock a treasure of unimaginable worth.'

While making due allowance for the rhetorical flourishes of Mr. West's sonorous style, I have always felt that there is much truth in this paragraph, especially as to the tendency to underrate the efforts of our pioneers, or, at any rate, to forget the courage which prompted them to risk, and enabled them to overcome, the hardships and trials which inevitably awaited them in this far-off land in the early days of last century.

In the early years of the nineteenth century Van Diemen's Land was a practically unknown quantity, the voyage out lasted nearly six months, and the only ships available were small, ill-found vessels of a few hundred tons burthen. Moreover, few of these voluntary exiles from the home-land could look forward, with any assurance, to revisiting their native land. Long and anxious must have been the family conclaves ere the fateful decision could be made.

One of the main inducements to emigration at that time was, of course, the depression that hung like a pall over Europe after the Napoleonic wars. The situation was, in many respects, extraordinarily like that of the present day. Prices were low, the burden of taxation was heavy, and trade was stagnant.

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[1] The following notes regarding the experiences of the pioneer settlers of V.D.L. are taken mainly from the correspondence of Mr. John Leake and his wife who arrived in Hobart Town in 1828 and from the diary of my grandfather, Dr. John Maule Hudspeth, who arrived in 1822.

From 1820 onwards a succession of publications drew attention at Home to the attractions of Van Diemen's Land. It was described (says West, p. 67) in *The Quarterly Review* for May, 1820, by a friendly pen, which stated that during three years a detachment of 100 men had not lost three, and that Hobart Town had been sixteen months without a funeral!

Lieut. Jeffreys, who came out to Van Diemen's Land in command of the brig *Kangaroo*, James Dixon, commander of the *Skelton*, and Edward Curr, the first Manager of the V.D.L. Coy., all published, between 1820 and 1824, books describing the island and advising intending settlers. G. W. Evans, the first Surveyor-General of Van Diemen's Land, who also came out in the *Kangaroo*, published in 1822 a description of Van Diemen's Land, in which he accuses Jeffreys of having appropriated on board ship some of his manuscript, and included it in his book. Evans' book contains a sketch of Hobart Town as it was in 1822. Curr's book contains a lengthy narrative of the career of Michael Howe, the notorious bushranger. Dixon includes in his book a copy of Macquarie's report of his visit to Van Diemen's Land in 1821, in which the population of the island is stated to be 6372 persons.

Godwin's *Emigrants' Guide to Van Diemen's Land*,[1] published in 1823, contains advice as to the procedure to be adopted to obtain a grant of land, and other useful information; also a small map of the island, and an interesting sketch of Hobart Town.

Among the letters to which I have had access is one written to the late Mrs. John Leake by her father, on the eve of her departure, with her husband and family, to Van Diemen's Land in 1822. In it he says:

> 'When I look back to your early childhood and consider that there was then not even the most distant prospect of your ever living or travelling beyond your native island . . . . to now hear you talk of removing almost as distant as it is possible to be . . . . not rashly, but calmly considering the privations and inconveniences naturally, with so many small children, attendant on so arduous an undertaking, is a proof of a great mind, fortified by a sense of duty rarely to be met with. May you both be blessed . . . . What may be the difficulties to be encountered in Van Diemen's Land I know not, and dislike to conjecture: of this I am assured—be they what they may, you would bear them with fortitude. But I hope and pray that fortitude may not require to be exerted . . . I truly hope, present difficulties over, you will find a resting place, and that the end will be peace.'

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[1] Curr (p. viii) severely criticizes Godwin's Guide as containing 'false and delusive assertions,' betraying 'gross ignorance.'

The decision taken, preparations for the voyage were immediately begun. The house and furniture at Hull were disposed of. Passages were secured on the brig *Andromeda*—a first-class cabin for Mr. and Mrs. Leake and the two youngest children, and berths in the steerage for the four elder children and three servants. The total passage-money was £380.[1]

Then came the purchase of the long list of articles to be taken for their new enterprise. These and the luggage were included in an insurance policy for £1500. They included the following items:—Wine, hardware and saddlery, paint, oil, slops, clocks, glass, soap, mustard, tins and corks, earthenware, corn mill, agricultural implements, plate, silks and ribbons, six chests of luggage, and one box of dollars. This formidable list gives us some idea of the forethought demanded of the intending settler in those days, and of the limited resources of the island.

In addition to all these, there was a most important item, viz., four Saxon sheep, with which Mr. Leake hoped to start his pastoral activities. These were procured in Leipzig, and, after a passage down the Elbe, shipped across to the Port of Leith, to be placed on board the *Andromeda*. For this a special licence had to be obtained, of which the following is a copy:—

Treasury Chambers,
10th September, 1822.

To John Leake,
Leith.

Sir,

I am commanded by The Lords Commissioners of the Treasury to acquaint you that my Lords have directed the Commissioners of Customs in Scotland to permit you to import from Hamburg to Leith Four Saxon sheep to be re-exported duty free to Van Diemen's Land, as required by you.

I am, Sir,
Your obedient servant,
R. LATHERGLEN.

Among their fellow passengers on the *Andromeda* were Messrs. Lewis Gilles and R. Horne, both of whom afterwards settled in the Macquarie District, and Dr. A. J. Ross, the well-known publisher of the early almanacs, who also cultivated other branches of authorship, verse, pamphlets, and an ethnological treatise; also the Rev. J. D. Lang, one of the first Presbyterian ministers in New South Wales, who afterwards started a newspaper in that colony; and letters of introduction were secured from Earl Bathurst and William Wilberforce to Sir Thomas Brisbane, Governor of New South Wales, and to Mr. Bromley, Naval Officer at Hobart Town. Mr. Wilberforce's letter is, perhaps, worthy of quotation:—

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[1] Average passage-money, £70 to £100 for cabin passengers, and £35 to £40 for steerage. Average duration of voyage, 100 to 140 days. (Curr.)

December 2nd, 1822.

Sir,

The Post which arrives late and goes out early at this place, allows one but a minute or two for writing to you, in addition to Letters in your behalf which I have just now dictated, to Sir Thomas Brisbane, and to Mr. Bromley, Naval Officer at Hobart Town.

I have also written in your favour to Earl Bathurst . . . And I can now only add my cordial good wishes, which the account of you received thro' Miss Terry has produced. (I well know the value of her praises), that it may please God to render your settlement in the Australasian Hemisphere productive of benefit to you and yours and to the community to which you belong.

Above all, may we be travelling the same road, though by different routes, and meet at length in a World of Holiness and Happiness and Love and Joy.

I remain with esteem
Sir
Your faithful
W. Wilberforce.

You had better not mention that my Letter to you is in my own Hand. In fact I should have dictated it, but my amanuensis is out of the way. I will just add, if this reaches you before you sail from England it may a little contribute to cheer you, that I have often thought were I to begin life in circumstances which did not promise much at Home, I would carry my family to Van Diemen's Land.

Mr. John Leake,
On board of the *Andromeda*,
Bound to Van Diemen's Land, at, or off, Falmouth.

Before embarkation the passengers were supplied with a complete schedule of the dietary to be enjoyed during the voyage. The schedule concludes with this significant paragraph:

> 'But the substituting of one article for another is to be at the entire control and pleasure of the Captain as he may find it convenient or desirable during the voyage.'

Notwithstanding this display of care for the welfare of the passengers' health, it became necessary, before the shores of England were left behind, for Mr. Leake to complain to the ship's agents of the quality of the food supplied to his children. The justice of the complaint was admitted, but the fact that it had been made unfortunately antagonized the captain, and was the cause of much misery and discomfort.

In passing it may be noted that, as was customary in those days, the ship sailed first westward, to call at Rio de Janeiro and to pick up the trade winds for the remainder of the voyage to Australia.

It appears from the *Sydney Gazette* shipping news for 1823 that the *Andromeda* left England on the 10th December, 1822, and arrived at Sydney, *via* Rio and Hobart Town, on 7th August, 1823—the voyage thus taking eight months.

Andrew Bent's *Almanac* for 1824 says that she reached Hobart Town on the 7th May, 1823—a quick passage.

In the early 'twenties of last century Hobart Town was little more than a depot for the reception of convicts. A few solid buildings for the military and civilian officials of the Home Government, and for the rest a number of rather ramshackle cottages, scattered in all directions, with the rivulet flowing along wooded banks to the blue waters of the Derwent. There were four watermills on the Hobart Rivulet. (Evans, p. 61.)

Lieut. Charles Jeffreys, R.N. (1820), says that the town contained 300 houses and 1200 inhabitants. The houses were of one story (with the exception of Mr. Birch's, now known as Macquarie House, which was of three stories, with an embattled parapet). Government House was in the centre of the main street, adjoining a square, known as 'George's Square.' There was a church (old St. David's) 'of modest dimensions,' a gaol (in Murray-street, on the site of the Hobart Savings Bank), and the Military Barracks, in Murray-street, near what is now Hadley's Hotel.

. The town must have grown rapidly, for West (1852) says that in 1821 it contained 426 houses and 2700 inhabitants, and Edward Curr (1824) says that in 1824 it contained 600 houses and a population of 3500, 'with new buildings rising up every day.'

The city had been laid out in 1811, under instructions from Governor Macquarie, by Meehan and Evans (the first Deputy Surveyor-General), but the streets were not formed. (Bigge's Report.)

Curr says the farm-houses in the country were mostly constructed of sods, logs, or mud, and thatched with straw.

In my grandfather's diary, written in 1822, he says, speaking of Hobart Town:

> 'There is very little cleared land in the vicinity of the Town. The streets are almost impassable for mud, and there is no meat of any kind to be had. Everything else is very dear. On Sunday I attended the Church (old St. David's). The Church is neat and commodious, the convicts sitting in the gallery set apart for them, and the free settlers and soldiers accommodated below. The attendance was, however, very thin. Service was performed too much in the Cathedral style, and the music more theatrical than sacred.'

Apparently the officiating clergyman's (Rev. Robert Knopwood's) reputation for spirituality was not remarkable, for he says, 'The Parson is not a man calculated to reform a depraved society, either by precept or example. He is both a swearer and a drunkard, and of course can have little real piety.'

From the first day of his arrival the newcomer was beset with difficulties. Often, upon unloading his effects, they were found to be destroyed or damaged by seawater which had got into the ship's hold. Even after they had been landed, they were frequently stolen on the shore, so frequently, indeed, that no one took any notice, and it was impossible to obtain redress. Then it was difficult to get any useful information from the officials, without bribing them, as to the land available for selection, and even when this had been obtained, there was the problem of getting up-country to inspect. In the same diary Dr. Hudspeth narrates how he eventually got away to examine the country round Jericho, which he had been advised was a suitable place for settlement. The Derwent River was crossed at Austin's Ferry, the country passed through being described as 'thickly wooded and little cultivated.' Treeless plains were passed, on which the town of Brighton was projected, with the intention of making it the capital. At Green Ponds a gang of convicts were employed in making a road. Oatlands had not yet been laid out, and at York Plains more convicts were encountered, quarrying stone for a bridge across the river. At this time the Main-road was completed as far as Constitution Hill. (Evans, 1822, p. 84.) Jeffreys says he drove from Hobart Town to Port Dalrymple over beautiful level pasture without more than 20 miles of road. (Evans, p. 87.)

On returning to Hobart, preparations were made to proceed into the country to settle. After considerable difficulty and delay a pair of bullocks was purchased for thirty guineas, together with a cart, for which a licence had to be obtained. It was difficult to get anything together, as 'No one's word was to be depended upon,' and a general muster of convicts held two days previously was kept up 'as a drunken festival.' (This sounds more like Governor Davey's administration than that of Governor Sorell!) However, at last a start was made, with three convict servants, Mrs. Hudspeth, with a baby daughter, being on the bullock-dray. The road was almost impassable, and progress was very slow. At Spring Hill the bullocks refused to go on, and the night was spent where they were, enlivened by an attack by two footpads, who demanded Mr. Hudspeth's gun, and he was held in considerable suspense until the return with light and firearms of the two men whom he had sent ahead for assistance. When Jericho was finally reached the little family took up its abode in a hut consisting of two rooms, divided by a partition made of wattle and clay, one being occupied by the family, and the other by the assigned servants. The bed for the master and his wife was made out of materials which 'in the morning had been growing on the plain.'

The system of assigning prisoners to settlers as servants was introduced by Governor King in 1804. (West, 1852, p. 126.) These assigned servants were apparently treated with considerable severity, especially for offences against discipline, and in regard to women, the latter due, no doubt, to the necessity for protecting them in their isolation. Thus we find that soon after their arrival at Bowsden, one of Dr. Hudspeth's servants was sentenced to 100 lashes and to be transported to Macquarie Harbour for the remainder of his original sentence, of which twelve years was unexpired. This was for insolence to Mrs. Hudspeth during the doctor's absence in Hobart Town.

In noting this in his journal Dr. Hudspeth states:

> 'Macquarie Harbour is a penal settlement which was established a few months ago, for the purpose of sending re-convicted offenders to; they are there hard-worked, ill-fed, and well whipped, and escape is impracticable. All who have attempted it have perished. A party of six, or eight, who ran off at first, were never more heard of, and some soldiers sent in pursuit of them never returned. Lately eight men made the attempt; two of whom got back, and just lived long enough to relate a horrid tale. By their account, the country on the West Coast is so rugged and barren that there is not a living creature to be seen, and it is intersected with ravines so deep and narrow that the sun's rays cannot penetrate to the bottom. In some of these chasms they were often up to the middle in dead leaves and moss, and the precipices above them were almost inaccessible. Their provisions were soon expended, and despair took possession of their savage breasts. It was proposed that one of the party should be slaughtered to feed the rest, and one of the name of Busby was doomed to be the victim, for he had planned their escapade, and undertaken to conduct them across the country to some settlement, and immediately they began with savage fury to murder him. He implored them to allow him to bleed himself to death, but in vain. They cut off his head, tore out his heart, and fried it, and afterwards gorged themselves upon his body. However, they all died but two, and they died also after their return.'

It may be useful at this point to digress for a moment, in order to explain the procedure adopted at that time by an intending settler to obtain a grant of land.

From 1803 to 1825 Van Diemen's Land was, in effect, a dependency of New South Wales, the colony not being granted responsible government until the latter year. Before leaving England the settler had to obtain from the Secretary of State for the Colonial Department an order to the Governor-in-Chief in Sydney, or the Lieut.-Governor in Hobart Town, authorizing him to issue a grant to the settler 'proportional to the means he may possess of bringing it into cultivation.' (Curr, 1824, pp. 92 *et seq.*)

Curr says the minimum amount of capital required to secure a grant was £500, but Jeffreys (1820) says that £200 would secure 200 acres. According to Evans (1822, p. 114) the Colonial Department required all settlers to have at least £500. (This regulation was probably invalid, as the Act 53 George III. c. 155 authorized any subject to settle in Australia without any licence.)

On arrival the settler lodged his letter with the Lieut.-Governor, together with a statement of his assets. He was presented by the Naval Officer to Lieut.-Governor Sorell, who pointed out the most eligible districts in which land was to be obtained. (It is said that Sorell was a most zealous immigration officer, and often succeeded in persuading those who had intended to settle in New South Wales to stay in Van Diemen's Land.)

The area granted was based upon the settler's means, as disclosed in his statement, but the maximum area was from 2000 to 2560 acres. In 1824 the Colonial Office fixed the maximum at 2560 acres and the minimum at 320 acres. Possession of £3000 would entitle him to 2000 acres, £1000 700 acres, and £500 to 400 to 500 acres.

Governor Davey was allotted a grant of 3000 acres by way of compensation for the capture by the Americans of his baggage, and this was the largest grant ever made to an individual. (West, p. 51.)

Extra land was occasionally given to settlers who had proved their worth and industry or done signal service to the colony, e.g., Gatenby, Batman, &c.

Having selected the spot on which he wished to settle, the next step was to obtain from the Deputy-Surveyor written permission to locate himself there. This was called a 'location order.' Owing to the delays which occurred in the issue of grants, many titles were founded upon these location orders alone.

There was also a regulation (not always enforced) that the settler should enter into a bond to maintain, if required, for a certain number of years, one prisoner for every 100 acres granted. If he took a second convict for one year, he was given a bonus of 100 acres.

Rations for the settler and his servants were also given at first.

Owing to the abuses which arose under this system, Governor Arthur set up a Land Board in 1828. Free grants were discontinued, and land was sold, at first by tender, and from 1831 by public auction. (West, 1852, p. 158.)

Immediately on his arrival at Hobart Town Mr. Leake set about securing a suitable grant of land. A formal application, with a letter from the Secretary of State for the Colonial Department, was lodged with the Lieutenant-Governor in the prescribed form, of which the contents were as follows:—

> Hobart Town, V.D. Land,
> 1823.
>
> Sir,
>
> Having arrived from England by the Brig *Andromeda* with an Order from His Majesty's Secretary of State for the Colonial Department for a Grant of Land proportioned to the Means that I possess for its cultivation and improvement, which Letter I have lodged in your Office, I beg leave to subjoin a Statement of the property which I bring with me, and which I intend to employ exclusively for that purpose, and to add that I am prepared to verify my Statement in any way that may be required.
>
> I have the honour to be,
> Sir,
> Your most obedient humble Servant,
> JOHN LEAKE.
>
> To
> The Secretary to His Honour
> The Lieutenant-Governor,
> V.D.L.

Upon this application, a Letter of Location was issued in the following terms:—

> Colonial Secretary's Office,
> 1823.
>
> To John Leake.
>
> Sir,
>
> In reply to your application for a Grant of Land, I am directed to acquaint you that the Lieutenant-Governor has been pleased to order a Location of 500 acres to be made to you upon condition of your cultivating and improving the Land and residing thereupon.
>
> When you have decided upon the Tract you wish to obtain, you will communicate with the Surveyor-General upon the subject, to enable that officer to furnish a description of the boundaries for the approval of His Excellency, and an Order will then be issued from this Office to authorise your occupation of the Land.
>
> I am, Sir,
> Your Obedient Servant,
> W. B. HAMILTON,
> Acting Colonial Secretary.

The next step was to select the land, and we find Mr. Leake setting off up-country on horseback, and with a bullock-cart, the usual mode of conveyance at that time, to explore; leaving his wife and children in rooms at Derwent Park.

In a letter, dated 19th July, 1823, he writes to his wife:

> 'We are all well, and have fixed on our land at the junction of the Macquarie and the Elizabeth. . . . Our cart upset on the road and broke the rum bottle, but did no other material damage. . . . We are at present at the Government Hut, our bullocks having strayed away, but I trust we shall find them to-morrow. We are within two miles of our land, and shall make all the speed we can with our building. . . . I think you will like this part of the country, and shall feel most anxious to get the family up here.'

Enclosed with this letter there is a sketch plan of the situation of the area selected.

The cost of hire of the horse for this expedition was £15. On his return to Hobart Town some weeks later, two assigned servants, 'Government men,' as they were then called, were secured, and added to the establishment, and fifty ewes and lambs at a cost of £1 per head, and in August Mr. Leake started off again for Campbell Town, distant ninety miles or so, this time on foot, and accompanied by his son Robert, aged about fifteen. On the way he sends by messenger a letter from Tin Dish, 21 miles south of Campbell Town, from which I quote the following:

> 'Robert walks very stoutly. We came yesterday from Watson's at Bagdad to Mr. Pike's at 14 Tree Plain, a distance of 26 miles. He was quite fresh. To-day we have come but 15 miles. Our sheep are about 4 miles before us. . . . As soon as our land is measured and I have got business into a proper train, so that our work may go forward in my absence (which I think will be very soon accomplished), I shall return and fetch you all up. The roads are very good now, and it is pleasant travelling, and I trust it will be so much warmer that we may bush it on our journey.'

By September the first hut was finished, and a start had been made with a second for the assigned servants. Crops had been sown and a garden laid out, and planted with the seeds brought from England. One of the boys was shepherd, and another baker and cook. Mr. Leake himself did the washing, as he writes: "This is my washing day . . . I have eight sheets already "firsted," as you call it; they will be clear washed and rinsed in the River . . . it makes them a beautiful colour.' He also says that one of the boys had only two shirts, which were very dirty.

Wages for assigned servants were, for males, £10 per annum, and for females, £7. The latter were often unsatisfactory, as will be seen from the following extract from a letter written by Mrs. Leake not long after she had settled at Rosedale:

> 'I do not think I shall be able to keep the woman servant. She goes about her work very unwillingly and inactively. I have to look after her quite as much as I should any man servant. She has been taking upon herself to say she should go away—I believe she said "run away." I have been obliged to give her a severe reprimand. This morning she told me you had said she was to have more than seven pounds per year; that you had promised it to her. I do not think her worth any more, but I do not think I shall be able to keep her, and am very sorry she was ever sent. She asked me for shoes to-day, and had never, till you mentioned it, said the cloak had been

> given in advance. As you said she was such a treasure I endeavoured to consider her as such, and treated her very kindly, but too much lenity will not do for these prisoners . . . I do not think women servants are suitable up the country, unless you need them for sickness or have a family of young children to look after . . .
>
> You will tell me exactly what you gave the woman to understand about her wages, because we do not give the men more than ten pounds a year, who do more work than the women. We cannot expect them to be satisfied if she is given more than her allowance. She tells me she told you she would not come for seven pounds a year, but I do not see how a Government woman has the power of dictating.'

In October, 1823, the household were alarmed by some people lurking about the premises, but a party of soldiers arrived from Norfolk Plains in disguise, looking for them, and they decamped without actually attacking the house.

We get a glimpse of the loneliness of bush life in those days from two letters, written in 1824, to Mr. Leake by Mr. William Pike, of Park Farm, from which I quote the following extracts:

> 'You have no doubt heard that 14 Bushrangers escaped from Macquarie Harbour, and landed in the Derwent, committing burglaries and robberies wherever they go. I am happy to say that five are taken, one has given himself up, and one has been wounded. The remaining seven are in the bush; the most reasonable supposition was that they had made for the Big Lagoon in our immediate neighbourhood. Parties of soldiers and constables have been here on the look out for some days, without success. We have been preparing to give them a warm reception, should they come in the night. I hope our prowess will not be put to the test. You have doubtless heard of the murder of a settler in our neighbourhood by the natives. They get excessively treacherous. Should they ever come near you, let no insinuation of theirs induce you to appear friendly; I am warranted in this remark by this murder.'

About 18 months after this another gang of bushrangers was in the vicinity, and we find Mr. Willis, of Wanstead Park, writing to Mr. Leake as follows:

> 'March 12, 1826.
>
> Sir,
>
> In obedience to the command of His Excellency the Lieutenant-Governor, I have to entreat the favour of your friendly co-operation with me in exerting our utmost vigilance in the capture of the broken ranks of Brady's party. Brady, I am happy to say, is taken, with Cody, Bryant, and Goodwin. It is supposed they

are lurking in the Forest; by prompt measures there is every hope of the whole being captured. I beg your immediate attention at my house with as many armed men as you can conveniently spare.'

Shortly after Mr. Pike's warning to beware of the natives a party of them was encountered on Rosedale, as narrated in the following letter, written by Mr. Leake, and dated 19th August, 1824:

> 'I have been now resident upon my farm in the centre of the island upwards of twelve months, and, though the native hordes, as we have observed by their fires upon the neighbouring mountains, have frequently been within the distance of a few miles, they have but once approached my dwelling. This happened about the month of March last. I was walking alone by the side of a new fence, which enclosed my arable ground, about 200 yards from the house, and was struck with astonishment to see four black figures sitting together on the ground, on the other side, with their feet in a hole, in which one of the posts was inserted, and which had not been quite filled up. I had scarcely recovered from my surprise before they all arose and discovered themselves to be four of what (in this case) cannot be described "the fair sex," and I as improperly accosted them in German . . . to which they replied with an unintelligent grin. Recollecting myself, I had recourse to signs, and putting my finger to my mouth, I said, "Bread? Bread?", when they nodded their approbation, upon which I signified by my hand that they should remain where they were whilst I went to fetch them some food. I soon returned with a loaf, and brought Mrs. Leake and some of the children with me to see them. We gave to each of them as much as they would eat, having understood that they never would divide anything they got with each other. We made various efforts to make ourselves understood, but to little purpose, and found when they spoke to each other that we could not catch any articulate sounds of their language, but they had evidently learned the word "Bread," and also "Tate" (Potatoes), from some previous intercourse with the English. After we had satisfied our curiosity, it being also dinner time, we left them munching their bread, and Mrs. Leake said, "Good bye, good bye." They repeated, and, mistaking it for an invitation to the House, they all suddenly leaped over the rails to come with us, but as they were very dirty in their persons, and had, besides, a kind of itch upon them, we were obliged to decline the honour of a nearer approach, and signed to them to remain as before. In a short time I returned, and brought with me a painted picture of the various costumes of the inhabitants of the earth, which I had brought from Hamburg . . . They appeared amused, and pointed to several

> figures, among which those of the greatest variety of colouring seemed to claim their chief attention. The border was also much admired, and one of the girls ran her finger with great pleasure all round it. They however seemed to restrain the expression of their curiosity within due bounds, as persons who could not be thought to be too much excited, and were therefore cautious of manifesting an ignorant and savage wonder. But when I rolled up the scroll quickly it quite got the better of their caution, and they all burst out into an involuntary laugh at this piece of ingenuity. As it was drawing on towards evening, I pointed to a small shepherd's hut close by, of which they took no notice, and seeming still unsettled, and having reason to suspect that a camp of men might be at no great distance, whose presence might be very inconvenient, if not dangerous, we entered into a kind of treaty with them, and gave them a quantity of raw potatoes, on condition of their going away, which they punctually observed, and went gaily off, singing and dancing as they went. Notwithstanding this manner of behaviour, I am of opinion these women come about as spies for the men, who, as you may have seen by our paper, deal very treacherously, and take every opportunity to spear a white man when it is in their power. I even saw one of the women, at a time when she thought herself unobserved, using violent gestures, and, as I thought, cursing the ground, but it might be all imagination. No doubt, however, they look upon us as intruders.'

In 1825 Mr. Leake was granted a further 2000 acres, which he rather naïvely states was 'a mark of the Governor's favor which perhaps I should not have obtained had I not been under his frequent notice.'

In 1829 the Derwent Bank was established in Davey-street, opposite the present Lands and Works Offices, and Mr. Leake accepted a temporary position there as accountant, which necessitated his living in Hobart Town, and leaving the management of Rosedale to Mrs. Leake. Prices for all farming produce and stock were then very low, sheep being sold for nine or ten shillings. It was therefore necessary to add to their income, and it was desirable, for other reasons, to have one of the family in the Capital. There was a good deal of trouble about that time with sheep-stealing, and what with that, and other troubles, poor Mrs. Leake felt greatly the responsibility and isolation. She writes in 1828: 'I think it very long to look forward to your return. I never felt more lonely in my life. I am at times almost melancholy.' Indeed, we can only marvel at the heroism of these women, many of them women of culture and refinement, uprooted from the sheltered existence they had enjoyed at Home, cut off from all the amenities of society, and planted in the bush among convict servants, bushrangers, and natives, and deprived of most of the ordinary comforts of life.

In a letter written from Hobart on 30th January, 1828, Mr. Leake says:

> 'I have seen two murderers executed to-day, and on Sunday I heard a sermon from the Archdeacon. The text was the sixth commandment, "Thou shalt not kill." Wherein he traced the rise of uncontrolled passion to obstinacy in youth, and shewed how, step by step, men arrived at the commission of crime. Let my dear Edward and Robert beware of despising reproof, nor think it a light thing to begin, by any act of disobedience to parents (or hereafter to masters), a career which could possibly lead towards such terrible results.'

In January of that year he gives us a glimpse of Hobart society:

> 'You ask what sort of people I have to do with. In primis, there is the Sheriff, Dudley Fereday, Esq.[1] He is a bachelor, with a broad Brim, dressed almost as plainly as a Quaker, and very regular and methodical . . . His house is very neat, and yet very plainly furnished, and I observe he sometimes dines in his butler's pantry, and sometimes in his kitchen . . . I breakfast at eight, lunch at one, dine at five, and drink tea at nine. Mr. Lee Archer, the Government Architect, Mr. Ferrar, Collector of Customs, Mr. Wedge, a surveyor, and a few others, are our daily party. No drinking or rioting, and the table open to ladies and gentlemen, the same as the boarding house at Scarborough.'

In April there was a ball at Government House, which is described as a very splendid one, but it rained the whole evening, so that the ladies, who had not, in general, carriages, were almost up to the ankles in mud. However, all were much pleased with the entertainment, and quite charmed with the Governor's (Arthur's) politeness, which much exceeded expectations.'

Mrs. Adey (presumably the wife of the cashier of the Derwent Bank), writing to *The Morning Herald* in 1827, draws rather a different picture of social life in Hobart Town at that time, at any rate in official circles, and of the atmosphere of Government House:

> 'The official corps,' she says, 'are punctilious; fearful of compromising their rank; all etiquette. Entertainments at Govern-

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[1] Dudley Fereday, Sheriff, is described by West (p. 129) as 'The most distinguished money-lender, whose ordinary charge was 35 per cent., or less with ample security. After a few years he returned (in 1834) to England, having realised £20,000 by usury. On his death he bequeathed a portion of his wealth to Oxford, to found a scholarship. Mr. Gellibrand applied to him with aptitude 'Burke's phrase, "His bible is his bill-book, and his gold his god."'

> ment House are ceremonies rather than parties of pleasure. As the servant opens the door he seems to say, "You may enter, but don't speak." Some more daring spirits would venture a remark, as ballast is thrown out to send a balloon above the fogs; but caution, like Sancho's physician, interdicted the perilous indulgence, and restored the watchful silence. No Dutchman would willingly endure the Humdrumstadt on the Derwent, notwithstanding its natural advantages and commercial promise—a town without a library, and where the common spirit of detraction was exasperated by competition for those favours the Governor could refuse or transfer. The presence of power was everywhere felt; and dreaded wherever it could not be defied.' (West, 1852, p. 115.)

We find a reference to Sir John Franklin in a letter dated 6th July, 1837, in which Mr. Leake says:

> 'I fully intended returning to-day, but as Sir John Franklin arrived I remained to attend his levée, and had the pleasure of being introduced to him by Capt. Montague at Government House. He appears to be a very affable man. He is rather low in stature, but stout and manly in his deportment.'

Soon after their arrival both Sir John and Lady Franklin held levées. I came across the following description of the ladies' levée in another old diary of 1837:

> 'Some of our Methodist ladies were present. Mrs. Dunn from her carriage was presented, dressed in a black satin dress with short sleeves and white net over them, a black headdress with three white plumes, and black satin shoes.
>
> 'Mrs. Orton wore a black satin dress, short sleeves with net over, headdress, and satin shoes.
>
> 'Miss Orton a pink satin slip, with white net over, white satin shoes, and head finely dressed.
>
> 'Sarah ——, more in character, walked there in plain black silk dress and Quaker bonnet, in consequence of which she rendered herself very conspicuous, and formed a subject of conversation to the whole Town.
>
> 'I am told the Justice Pedder's lady became so much annoyed at length with the kind of company that she left Government House in disgust, and went home.'

Evidently human nature has not changed much from those early days!

And now, having seen our settlers fairly started on their new life it is time to take leave of them. It would be beyond the scope of this paper to follow their fortunes further, though the later letters and papers afford us enticing glimpses of people and events which have long since passed into history, and which make us wish to linger. A procession of Governors, from Sir George Arthur to Sir William Denison, passes across the stage: we see the sons of settlers presenting a formal petition to the Governor, protesting against the discontinuance of grants of land: we find a circular, dated 11th June, 1841, asking for subscriptions towards the establishment of a school in memory of Archdeacon Hutchins, with a list of subscribers, headed by Sir John and Lady Franklin: another circular, dated December, 1843, appealing for funds for the completion of Trinity Church, 'the roof of which was then nearly finished': a lengthy memorandum setting out the views of landholders against the cessation of transportation, which was the subject of such violent agitation: a document surrendering to the Crown an area of land at Risdon for the purposes of a bridge across the Derwent (which, after the lapse of over 80 years, is still unbuilt); the passing of an Act to authorize the construction of a road to Brown's River along the banks of the Derwent: a petition to the Queen, praying for the establishment of a Legislature to be elected by the people; and many other references to matters of public interest, on which time will not permit me to dwell.

On the purely personal side, we see Mr. Leake extending his holdings of land and of flocks and herds, and gradually being appointed to offices and duties of a public nature; and finally becoming a member of the Legislative Council: his sons crossing to the mainland, to find wealth and prosperity during the gold rush: the humble cottage of wattle and daub giving place, first to a modest cottage, and eventually becoming the stately mansion which now crowns the foothills of the Western Tiers.

And, as we pore over the yellowed pages, with their faded caligraphy, there emerges from the mists of the past a vision of high endeavour, of dauntless courage, and of unswerving faith, which stirs our hearts, and fills us with gratitude, admiration, and pride.

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Observations on Visits of the Tasmanian Aborigines to the Hunter Islands

By

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(Read 30th September, 1935)

The Hunter Islands lie off the north-western extremity of Tasmania and cover a considerable area. The principal islands of the group are Robbins, Hunter or Fleurieu, and Three Hummock. In addition there are many smaller islands, islets, and rocks, the chief of which are Trefoil, Bird, Stack, Steep, Penguin, Walker, the Petrels, and Albatross. This group of islands was discovered and named by Flinders in 1798, when he and Bass circumnavigated Tasmania in the sloop *Norfolk*. Landing on Three Hummock, they were surprised to find upon the shore 'several deserted fireplaces strewed round with the shells of the sea ear'. (Flinders, 1814.) This puzzled Flinders, for he thought that the natives were entirely ignorant of the art of navigation.

In August, 1934, Mr. Roy Harvey, of Devonport, made it possible for me to visit the group in his fishing-boat. On both Hunter and Three Hummock I found abundant traces of aboriginal visits.

Hunter, or Barren Island, as Flinders named it, is separated from the mainland of Tasmania by a strait 3 miles wide. It is a narrow island, 14½ miles long, running north and south, and has an area of 21,000 acres. The northern part is very barren, but in the south the soil is better, and the hills are wooded. All around the coast I found small heaps of shells, the remnants of many an aboriginal meal. On the western side, in a sheltered corner in the southern part of Cuvier Bay, there were some well-grassed middens. At Reynard Point, on the east coast, there is a large cave in a slate cliff. This cave is 20 yards wide at the entrance, runs back into the cliff for about the same distance, and is everywhere lofty. It is perfectly dry, provides excellent shelter in all weathers, and is well lighted. From the entrance there is a splendid view to the south. The abundance of shell remains and two deserted fireplaces, a large one in the centre of the cave, a smaller one not far from the end, give ample evidence that this was a favourite haunt of the aborigines.

I purposed to visit Stack Island, where a few years ago the complete skeleton of an aboriginal woman was found, but the wind veering to the east with that disconcerting suddenness which is characteristic of the region, we were forced to run across to Three Hummock Island and lie there. The easterly weather continued for three days, when the wind suddenly chopped round into the north-west and blew a hard gale, forcing us again to run for shelter. The continuance of rough weather made a visit to Stack utterly impossible.

Three Hummock Island lies to the eastward of the northern portion of Hunter Island, from which it is separated by a passage 2 miles wide, with depths from eight to twenty fathoms, deep water extending very close inshore on both sides. Three Hummock is roughly oval in form, and is much more fertile than Hunter. Its area is 23,000 acres. Open downs run out to a well-wooded ridge in the east, which rises into three conical-shaped hills, the highest of which, that in the south, reaches 784 feet. It is from these hills that the island takes its name. Here, as on Hunter Island, I found the relics of many aboriginal feasts. In the sand-blows, bones of marsupials and birds were associated with shells, and shell heaps here and there all round the coast were common.

On both islands game is plentiful, and there is an abundance of fresh water. But, as Flinders pointed out, the small size of the islands renders ‘ the idea of fixed inhabitants inadmissible ’, for a permanent occupation would soon exhaust the game and deplete the supply of shell-fish. It was, however, not the abundance of wallaby, opossum, crayfish, and shell-fish that induced the aborigines to visit the islands, but the mutton-bird rookeries. On both Three Hummock and Hunter, as well as on the smaller islands, mutton-birds breed in great numbers. Flinders has left us an account which reveals, in no uncertain way, the vast numbers of these birds at the western end of Bass Strait in 1798, at a time when the aborigines roamed freely throughout Tasmania.

As the *Norfolk* lay at anchor off Three Hummock Island a stream of mutton-birds came from the southward. This stream Flinders reckoned was 300 yards or more in breadth and from 50 to 80 yards in depth. For a full hour and a half the flight continued. The birds were not scattered, but were flying as compactly as a free movement of their wings seemed to allow. ‘ Taking the stream to have been 50 yards deep by 100 yards in width,’ he writes, ‘ and that it moved at the rate of 30 miles an hour, and allowing 9 cubic yards of space to each bird, the number would amount to 151,500,000. The burrows required to lodge this quantity of birds, allowing a square yard to each burrow, would cover more than 18½ square miles of ground ’.

Mutton-birds (*Puffinus tenuirostris*) arrive at the islands towards the end of September. The nesting burrows are first cleaned out, then the birds leave for sea again, returning on or about the 25th

November, when the laying season begins. Only one egg is laid. This takes about eight weeks to hatch. The young birds are unable to fly before the end of April.

To-day mutton-birding is an important industry on the islands at both ends of Bass Strait. The young birds are taken, salted, and exported in thousands to Hobart, Launceston, and Melbourne, where they find a ready sale as an article of food. When salted, the flesh of the bird may not appeal to all tastes, but fresh, it is delicious. The habits of the mutton-bird would be as well known to the aborigines as to us. No wonder, then, that they sought to avail themselves of this bountiful food supply. Once at the rookeries they had no difficulty in getting as much food as they required with little effort. Not only were they able to get the food easily, but the eggs and the flesh of the nestlings provided a pleasant change from the usual diet of shell-fish and marsupials.

As mutton-birds do not breed on the mainland, the aborigines were obliged to cross to the islands. This is no easy matter. Although only 3 miles separate Weber Point, the southern tip of Hunter Island, from Maundy Point (Woolnorth), the crossing bristles with difficulty, and to make it requires sound seamanship. Through this waterway there is a tremendous tide-rip. At springs it attains a velocity of 5 knots, and 3 knots at neaps. At no part of the seaway between the islands and the mainland is there less than a 2-knot current. Nor does the tide ebb one way and flow another. The top half sets westward and the bottom half eastward. In other words, the west-going or flood stream begins at from four and a half to three and a half hours before high water, the east-going or ebb stream begins from three to three and a half hours after high water. So strong is the tidal stream, that near the great number of rocks, reefs, and sunken banks heavy races are formed, and in the channel many swirls and eddies. Even a slight breeze causes a steep, ugly sea, and demands expert seamanship. And it must be remembered that in this vicinity calm weather is rare.

It is sometimes maintained that the aborigines crossed from the mainland to these islands by swimming, but I regard this as an impossibility. Often have I watched the tide setting through the strait, but never, even on a calm day, have I seen conditions favourable for swimming the 3-mile waterway, even by a very powerful swimmer. To get across, a serviceable boat is necessary.

It is well known that the aborigines crossed to Maria and Bruni Islands; and Flinders relates that, as the *Norfolk* passed between the Maatsuyker Islands and the mainland, he 'saw with some surprise, for it is three miles from the main, that its grassy vegetation had been burnt'. As many artifacts have been found at Tasman Island, it is clear that the aborigines also visited it, and, from the nature of the coast-line, this would entail a voyage of six or seven miles.

When James Backhouse, visited Macquarie Harbour, in June, 1832, he was informed by the pilot at the Heads that the aborigines 'cross the mouth of the harbour on floats in the form of a boat, made of bundles of the paper-like bark of the swamp Tea-Tree, lashed side by side by means of tough grass. On these three or four persons are placed, and one swims on each side, holding it with one hand'. (Backhouse, 1843, p. 58.) He was told also that, three months earlier, five boats had gone across in this way, and among the party were several children. (Walker, 1902.) This method of propulsion is eminently suitable for short stretches like the entrance of Macquarie Harbour, where, at slack water, the crossing could be speedily made, but it would not suit the Hunter Passage, which steam-driven vessels can use only with the utmost caution.

Many of the early visitors to these shores and a number of the early inhabitants saw native boats, but very few took the pains to describe them.

In his diary, under the date 21st June, 1804, the Revd. R. Knopwood, telling of Mr. Collins'[1] return from the Huon, where he saw many natives, writes: 'He see three of their cattemerans or small boats made of bark that will hold about six of them'. In 1827 a party, of whom Jorgen Jorgensen and Clement Lorymer were the leaders, journeyed down the west coast of Tasmania. At the mouth of the Pieman they 'saw a number of catamarans, on which the aboriginals are in the habit of crossing the river'. West (1852) reports that Lieut. Gunn found at Maria Island, and preserved for several months, a catamaran sufficiently tight and strong to drift for 16 or 20 miles; each would convey from four to seven persons. Although the term 'catamaran' is used on many occasions to describe the Tasmanian aboriginal craft, the name is not of much service to us, for it is indiscriminately used for log rafts, outrigger canoes, or primitive reed or bark floats.

From the various descriptions given, the Tasmanians apparently constructed two different kinds of craft. For the best description of one kind we are indebted to Freycinet, who was with Baudin's expedition which visited D'Entrecasteaux Channel in 1802. 'We have seen and measured several of them', he writes, 'which were of the same size and put together in the same fashion. Three rolls of Eucalyptus bark form one body. The principal roll or piece was 4 m. 55 cm. [14 ft. 11 in.] long by 1 m. [3 ft. 3 in.] broad, the two other pieces being only 3 m. 90 cm. [12 ft. 9 in.] long by 32 cm. [12⅝ in.] broad. These three bundles which bore a fair resemblance to a ship's yards were fastened together at their ends: this made them taper and formed the whole of the canoe. The scarfing was made fairly compact by means of a sort of grass or reed. So completed the craft had the following dimensions: length inside 2 m.

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[1] Lieutenant-Colonel Collins, the Governor of the Colony.

95 cm. [9 ft. 8 in.]; outside breadth 89 cm. [2 ft. 11 in.]; height 65 cm. [1 ft. 3½ in.]; depth inside 22 cm. [8½ in.]; thickness at the ends 27 cm. [10½ in.]. Five or six savages can get into these canoes but generally the number is limited to three or four at a time. Their paddles are simple sticks of from 2·50 m. [8 ft. 1 in.] to 4 m. [13 ft.] or even 5 m. [16 ft. 3 in.] long by 2 cm. [¾-in.] to 5 cm. [2 in.] thick. Occasionally when the water is shallow they make use of these sticks to propel themselves as we do with poles. Generally they sit down when working their canoes, and make use of a bundle of grass as a seat; at other times they keep standing. We saw them crossing the channel only in fine weather. . . . They always place a fire at one end of their canoes, and, in order to prevent the fire from spreading, they place underneath it a sufficiently thick bed of earth or cinders'.

At Maria Island he saw more canoes of the same shape. The only difference was 'that instead of the bark of the eucalyptus trees they used nothing but a kind of reed which grows in abundance at Oyster Bay'. (Freycinet, 1816.) The construction of such boats shows considerable ingenuity in utilizing unpromising material. The grass and reeds used to caulk the gap between the two upper bark rolls and the lower one must have been quite effective, for, as Freycinet tells us, the boat was sufficiently watertight to carry a live fire. Notice, too, how skilfully the bark was streamlined into boat shape, so that the craft was sharp at bow and stern, or, as Calder expresses it, 'something like a whaleboat'. Such boats were first constructed many thousands of years ago, and the knowledge of building them was brought to Tasmania by the aborigines as part of their acquired skill when they migrated hither. The earliest evidence we have of such a canoe comes from Egypt, where we find them figured on painted jars of the Middle Predynastic period, that is, between 4000 and 4500 B.C. Similar boats are still used on Lake Tana in Abyssinia, on Lake Chad in Tropical Africa, in South Africa, and in Peru. Bonwick (1870, p. 51) quotes the description of Mr. Roberts, formerly of the Bruni salt works: 'They were of thick bark interlaced like a beehive with Corrijong bark string, and were strong enough not only to carry men across that stormy sea, but even, on the Southern Ocean, to De Witt and other islands which were visited by the Natives on sealing excursions. The head and stern were raised high above the water like horns. Each boat would hold from four to six men. Long sticks or spears, or bark paddles[1] plied first on one side, then on the other, supplied the place of oars and propelled this rude contrivance as quickly as an English whaleboat'.

Labillardière (1800), who visited Tasmania with D'Entrecasteaux in 1792, thought such craft as fit only for crossing tranquil water.

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[1] Paddles were no doubt acquired from the English.

Freycinet was of the same opinion: but they were giving utterance merely to what they thought. The seaworthiness of such craft is attested by an old whaler, who told Bonwick that 'he had seen one of them go across to Witch Island,[1] near Port Davey, in the midst of a storm'.

The other form of boat is that described by Amasa Delano (1817), the American skipper and owner of the whaler *Pilgrim*. Delano, who visited the Derwent in March, 1804, afterwards wrote an account of his voyages and travels, and made some observations on the Tasmanian aborigines. In the course of his remarks he says, 'I observed at the same time that they had three or four small rudely constructed and ugly shaped canoes with them with two outriggers each'.[2] Delano was a seaman who had sailed round the world and had poked into many odd corners. When he said 'outriggers' he knew what he was speaking of, and what he saw must have had some resemblance to the outriggers seen in the islands of Indonesia. That the Tasmanians had a knowledge of so advanced a type of boat as a canoe with the double outrigger is, to say the least, highly improbable. Lieutenant Charles Jeffreys, however, gives a description which is illuminating: 'The natives selected two good stems of trees about 30 ft. long and placed them about 6 ft. apart, parallel with each other. Cross pieces were laid on these and secured to the stout stem by bark ropes. In the middle a cross piece stronger than the others was securely fastened. The whole was then more or less covered with wicker work. In this way a raft 30 ft. long, able to hold from 6 to 10 persons, would be constructed. By means of paddles it could move on the surface of smooth water with amazing rapidity and safety'. (Jeffreys, 1820.) 'Wicker work' is no doubt a euphemism for a rough interlacing of thin, pliant tree stems, but the general idea is quite clear. What he described was an improved raft made of two logs, placed parallel to each other at a distance apart, with a platform laid on cross-poles between them. This platform did not necessarily cover the whole space between the poles either lengthwise or longitudinally. Jeffreys, it must be noted, says '*more or less* covered with wicker work'. The platform not completely filling the space between the logs would form the 'rudely constructed and ugly shaped canoe' of Delano, and the two parallel logs the floats of the outriggers.

Mrs. Meredith (1852) writes of similar craft: 'They were formed of many little bundles of gum tree bark, tied with grass, first separately, and then bound together in the required form, thick and flat, without any attempt at the shape of a boat or canoe, and not keeping the passenger above water when used, but just serving to float him on the surface. In, or rather on, these the natives sat and paddled about with long sticks or drifted before the wind and tide; and in calm weather frequently crossed over from the mainland to Maria Island; but on such occasions they provided a little raised platform on the raft, on which they carried some lighted fuel to kindle their fire when they arrived there'. The last sentence throws much light on the apparent inconsistencies in the various accounts of native craft. The natives built to suit their purpose. If a narrow waterway, such as a river, was to be crossed, they used a log or a rough and ready structure of bark or reeds; but, when the occasion demanded, they built something really seaworthy.

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[1] This is de Witt Island, the largest of the Maatsuyker Group.

[2] Ling Roth does not mention this description.

The different accounts of native craft prove conclusively two things. First, that the native craft, whether we think of the raft or the canoe, could remain afloat for a long time, and secondly that the natives could drive them along at a fast rate.

That they could make the extremely difficult crossing between the mainland and the Hunter Islands proves them expert and fearless seamen. But it would seem that they were accustomed to perform an even more dangerous voyage. Eight miles north-west of Cape Keraudren, the northern point of Hunter Island, lies Albatross Island, a steep rocky mass. Since the natives named this Tangatema, and left larger islands unnamed, it would appear they sometimes visited it. Here, no doubt, they hunted seals, which frequented this rocky islet in such great numbers that Bass had to fight his way through them when he landed there in 1798. This island, like the Maatsuyker Group, is exposed to the full force of the Southern Ocean. On account of the great swell which breaks upon its rocky shores almost continually, and the strong tide-rips off both ends, it is very rarely visited even by men of our own race in modern craft. Landing there is almost always hazardous, and one must be prepared to slip away at a moment's notice.

In face of such seamanship it seems idle to demand a land bridge for the migration of the aborigines to Tasmania. Even at the present time a boat could leave Wilson's Promontory and cross Bass Strait to Tasmania without once being out of sight of land. The greatest gap, that between Deal Island and Flinders Island, is less than 30 miles. When we remember that Bass, Flinders, and a boy sailed from Port Jackson and explored the coast to the southward in a little vessel 8 feet long, surely we must allow it possible for natives in a boat nearly 2 feet longer to cross from Australia to Tasmania, using the islands as stepping-stones, and having, at most, to make an unbroken run of 30 miles. And the probability is, that when they crossed, the greatest gap was considerably less. Moreover, at each stopping-place there is a permanent supply of fresh water. Had the urge been there, their descendants, the aborigines known to the early settlers, in boats such as Freycinet described, could easily have managed such a voyage.

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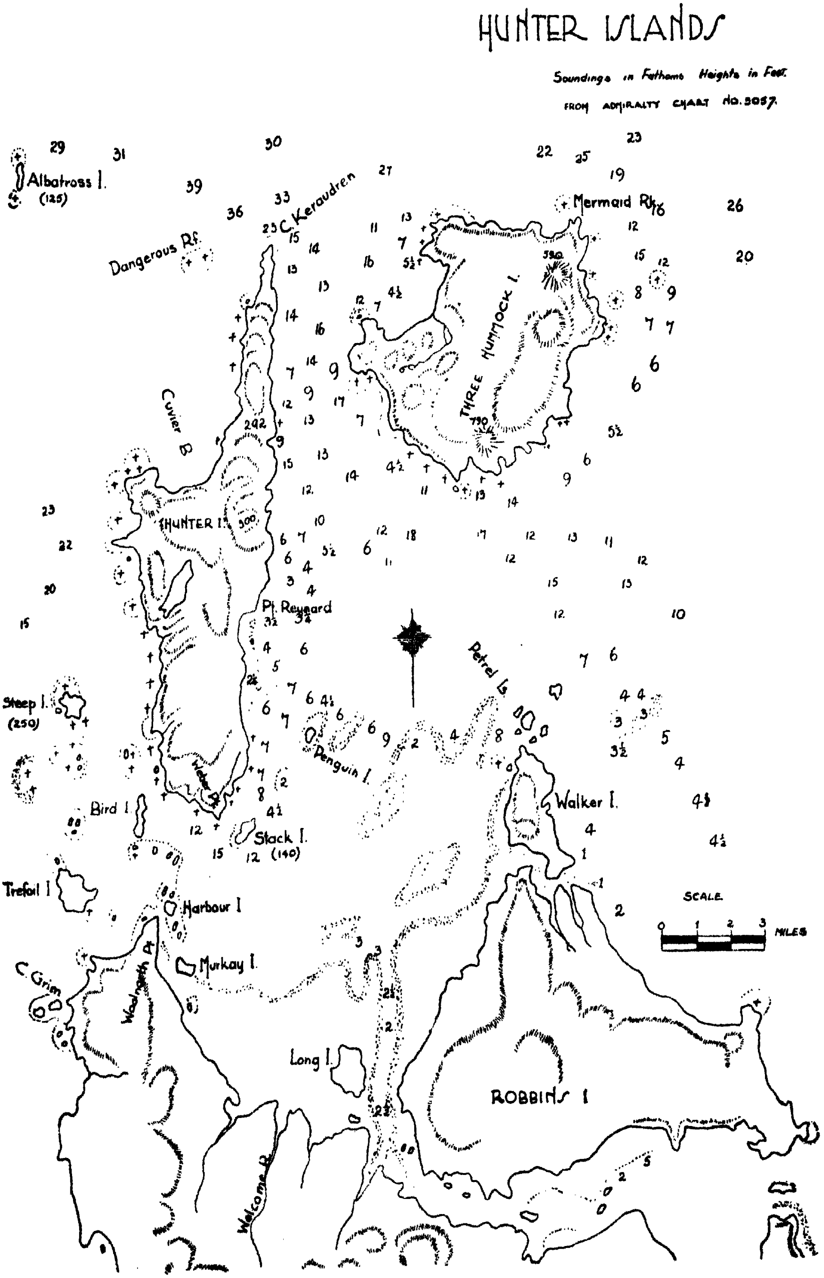
HUNTER ISLANDS
Soundings in Fathoms Heights in Feet
FROM ADMIRALTY CHART No. 3057
Albatross I.
(125)
Dangerous Rf.
C. Keraudren
Mermaid Rk.
THREE HUMMOCK I.
590
790
Cuvier B.
292
HUNTER I.
500
Pt. Reynard
Petrel B.
Steep I.
(250)
Penguin I.
Walker I.
Bird I.
Stack I.
(140)
Trefoil I.
Harbour I.
Murkay I.
C. Grim
Woolnorth Pt.
Long I.
ROBBINS I.
Welcome R.
SCALE
0 1 2 3 MILES

PAP. & PROC. ROY. SOC. TASMANIA, 1935 (17TH AUGUST, 1936).

The Whales and Dolphins of Tasmania

Part I. External Characters and Habits[1]

By

JOSEPH PEARSON

Whales are mammals which have become entirely aquatic, though there is every reason to believe that they have been derived from land mammals. As in the case of the specialized ichthyosaurian reptiles, the aquatic environment has imposed upon whales a fish-like form; the head passes imperceptibly into the trunk without a constricted neck; the anterior limbs or flippers have lost all external semblance to the typical mammalian fore-limb; and the hind limbs have disappeared. though internal skeletal vestiges still persist. A dorsal fin is generally present, but does not contain skeletal supports as in the case of fishes. The well-developed caudal fin has no skeleton, and differs from the vertical tail of fishes in being prolonged laterally into fleshy horizontal expansions, the flukes. The nostrils (blowhole, single or double) are situated high upon the vertex of the head. The eyes are small, the external part of the ear is almost non-existent and has no pinna. Teeth are generally present at some stage in the life history, but in whalebone whales the teeth disappear before the end of foetal life. The blubber, which is characteristic of whales, is a thick subcutaneous tissue containing fat, and is impregnated with oil. The hairy covering, which is present in all mammals, is reduced to a few isolated hairs in the region of the mouth, and the body is naked and shiny. This group includes the largest animals which have ever lived.

The term ‘ Tasmanian whale ’ is a misnomer, as it is only in exceptional, and for them unfortunate, circumstances that members of the Cetacea become stranded. The natural habitat of most whales is the high seas, and they have as a rule a very wide distribution. In fact, no other group of animals, except man, is so cosmopolitan. For the purposes of the present account it has been deemed necessary to include in the list of Tasmanian whales only the forms of which some record exists either of their having been stranded on Tasmanian beaches or seen in the adjacent seas.[1]

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[1] The original purpose of this paper was to give a comprehensive account of Tasmanian whales. Owing, however, to limitations of space, it has been found necessary to divide this account into two parts; the first, dealing with the external characters and habits of whales, forming the subject of the present paper; and the second, being concerned with internal anatomy and osteology, which, it is hoped, will find a place in the next issue of this Journal. In a way, this separation may be regarded as a fortunate circumstance, for while a comparatively large number of people may be interested to learn about the external appearance and habits of whales, only the specialist would be interested in the anatomical details.

Whales may be divided into two main groups:—

1. Absence of teeth in adult. Presence of whalebone. Blowhole double. Lower jaw very wide, the halves curving outward and being loosely united in front. Females larger than males	The Whalebone Whales (sub-order *MYSTACOCETI*)
2. Presence of teeth. Absence of whalebone. Blowhole single. Lower jaw triangular, narrow in front, the two halves firmly united. Males larger than females . . .	The Toothed Whales (sub-order *ODONTOCETI*)

WHALEBONE WHALES

Sub-order **Mystacoceti**

The main external characters of this sub-order are given above. There are at least six species of whalebone whales found in Tasmanian waters, namely, the Southern Right Whale, now almost extinct, the Humpback, formerly very abundant, now not so common, the Blue Whale, the Fin Whale, the Piked Whale, and the Sei Whale, the latter probably being a rare visitant to sub-antarctic waters.

All of these whales are hunted for their oil. In the early days of southern whaling the Southern Right Whale was one of the principal objects of capture; now it is almost extinct and is protected under a convention entered into recently by twenty-four nations, including Australia.[2] Later the Humpback formed the main object of southern whaling expeditions, but at the present day the Blue Whale and Fin Whale constitute over 90 per cent. of the catches of most southern whaling stations, the two being caught in nearly equal numbers (Mackintosh and Wheeler, 21, p. 272).

Until recently the whalebone, or baleen, was also valuable owing to its use in ladies' garments. The plates of baleen are suspended from the roof of the mouth, and the frayed edges of the plates form an efficient sieve through which the animal sucks the sea water, and in this way sifts from the water enormous quantities of minute crustaceans, collectively known as 'Krill', which consists principally of *Euphausia superba*.

The period of gestation of the whalebone whales is nearly one year, and the females produce calves every two years. The average size at birth of whalebone whales is from 25 per cent. to 30 per cent. of the maximum size of the adult.

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[1] There is every reason to believe, however, that in addition to the forms dealt with in the present paper the following whales and dolphins are to be found in the seas around Tasmania:—*Hyperoodon planifrons, Berardius arnuxii, Cephalorhynchus hectori, Delphinapterus leucas, Grampus exilis, Sousa gamadu, and Tursiops catalania.*

[2] Japan is not a signatory to this convention. This convention also prohibited the capture of immature whales of all kinds.

In southern seas the whalebone whales have a definite migration, generally passing north, so as to spend the winter months near the equator. In most cases the young are born at this period, and this northern migration may be regarded as the *breeding migration*. They pass southward again for the summer, presumably in search of planktonic food, which is more abundant in antarctic waters than in the warmer seas. This is known as the *feeding migration*.

The statement made by whalers that the whales of the genus *Balaenoptera* can remain under water for eight to twelve hours without coming up to breathe is not supported by the facts. Normally a large whale remains below water for five or ten minutes, or in extreme cases as much as forty-five minutes. After having been submerged the whale comes up to breathe, and as soon as the nostrils reach the surface the first process is to expel the deoxygenated air from the lungs. The hot, moist air passing out into the colder atmosphere forms a column or 'spout' containing particles of condensed water. This expiratory process is made with considerable force, and often produces a distinct whistling sound. Thus the whale is said to 'blow'. For some minutes after having come to the surface the whale will go through the inspiratory and expiratory processes several times, and normally may blow two or three times a minute. Eventually when the lungs are completely recharged with a fresh supply of air the whale will 'sound', i.e., it will dive to a considerable depth, the maximum depth being at least 100 fathoms. In sounding the Right Whale, Humpback and Sperm Whale leave the surface in a vertical position, the large tail being the last part of the animal to disappear. In the Fin Whale and other members of the genus *Balaenoptera*, the animal, when about to sound, gradually sinks below the surface in a more or less horizontal position, so that the flukes are not seen standing up from the surface of the water.

The Tasmanian forms of whalebone whales may be distinguished as follows:—

1. No grooves on throat:	
(i) No dorsal fin	family *BALAENIDAE* *Southern Right Whale*
(ii) Dorsal fin present	family *CAPEREIDAE* *Pygmy Whale*
2. Numerous grooves on throat	family *BALAENOPTERIDAE*
(i) Flippers nearly one-third the length of the animal	*Humpback*
(ii) Flippers not more than one-eighth the length of the animal:	
(*a*) Bluish-grey. Whalebone and bristles black	*Blue Whale*
(*b*) Grey above, white below. Whalebone dark-grey striped with white, bristles grey	*Fin Whale*
(*c*) Grey above, white below. Flippers with white band. Whalebone yellowish-white, with bristles of same colour	*Lesser Piked Whale*
(*d*) Bluish-grey above, lighter below. Whalebone black, bristles grey or white	*Sei Whale*

THE RIGHT WHALES

Family *Balaenidae*

Head more than one-fourth the length of the body. No dorsal fin. No grooves on throat. Plates of baleen long and narrow.

1. SOUTHERN RIGHT WHALE

Balaena australis Desmoulins, 1822

This species was described by Desmoulins in 1822 from a specimen from the Cape of Good Hope. In 1843 Gray gave the name *Balaena antipodarum* (and later in the text, presumably in error, *B. antipodum*) to the New Zealand right whale in Dieffenbach's Travels (6). The New Zealand and South African forms belong to the same species.

DISTRIBUTION. This whale is now almost extinct, though formerly it was abundant throughout the southern seas, mainly between 20° S. and 55° S. (commonest about 35° S.). In this connexion it is interesting to note that Governor Collins, writing to Sir John Banks from Hobart Town in July, 1804, stated that for six weeks the Derwent estuary had been 'full of the whales called by the whalers, the Right or Black Whale'. It is now wholly protected under a recent International Convention of the League of Nations. There is only one species of right whale in southern waters, and it is generally accepted that this species differs from the northern right whales.

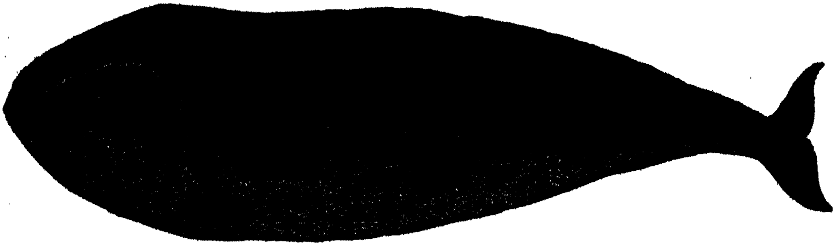

Fig. 1.—The Southern Right Whale (*Balaena australis*)

EXTERNAL CHARACTERS. Maximum length, about 18·25 m. (60 feet). No dorsal fin. No longitudinal grooves on throat. Head large, about a quarter the length of the body. *Colour,* generally uniformly black. Sometimes black or greyish-black above, lighter on the ventral surface. *Whalebone,* black, about 200 plates on either side. These plates have a maximum length of about 22·8 cm. (7 ft. 6 in.) No detailed external measurements of this whale are known to me.

NATURAL HISTORY. This species is the 'Black Whale' of the early southern whalers. Dieffenbach (6, Vol. 1, pp. 42-55) gives a detailed account of the habits of this form. Females come inshore in the winter months to calve. When accompanied by their young the females of this species are easily captured. Males are seldom captured, as they rarely approach the land. This whale blows every 10 or 15 seconds. According to Dakin (5, p. 338) a Southern Right Whale produced an average of 55 barrels of oil, valued at £250.

The Southern Right Whale was formerly fished in the sub-antarctic sea immediately to the south of Australia, in the South Pacific (New Zealand waters, and to the north and west of Chatham Island, on the Coast of Chile Ground, off South America), in the South Atlantic (Brazil Banks and False Banks, the Falkland Islands, off South America, the Pigeon and Tristan Grounds, off the Cape of Good Hope, and the Woolwich (Walfis Bay) Ground), and in the South Indian Ocean (Delagoa Bay Ground, Crozettes Ground, Desolation Ground, and the grounds north of St. Paul). The seasonal migration does not appear to have been very extensive, but on the whole the records show that the whales went north for the winter (July) to a northern limit of 20° S., and migrated south for the summer (January) to a southern limit of 55° S. Most of the whaling was done in the vicinity of the 35th parallel.

For a comprehensive account of ' Black Whale ' fishing see Crowther (4).

Family *Capereidae*

Head about one-fourth the length of the body. Dorsal fin present. No grooves on throat. Plates of baleen long and narrow.

2. THE PYGMY WHALE

Caperea marginata (Gray, 1846)

SYNONYMY. This species was founded in the first instance upon the whalebone only. Later, in 1864, the earbone was described separately and a new genus *Caperea* founded. In 1870 the skull, with the whalebone attached, was first described from New Zealand, and Gray, later recognizing the peculiarity of this skull, founded the new genus *Neobalaena*. In 1872 Hector re-examined the New Zealand skull, and found that the earbone agreed with that of *Caperea*. This name, therefore, has priority over the later name *Neobalaena*.

DISTRIBUTION. Recorded from New Zealand and the southern half of the Australian coast. Probably occurs throughout the Australian portion of the sub-antarctic seas. Apparently a rare species.

EXTERNAL CHARACTERS. *Colour*, black above, paler below. Maximum length about 6·1 m. (20 ft.). Body slender. Small head, less than a quarter the length of body. Dorsal fin present. No longitudinal ridges on throat. *Whalebone* differs from that of any other whale. It is extremely narrow. Ivory coloured, the outer margin having a characteristic dark band. Longest plate examined by me, 78 cm. (31 in.). Width 7 cm. (2¾ in.). Hector (15) records 230 plates on each side in a specimen from Stewart Island.

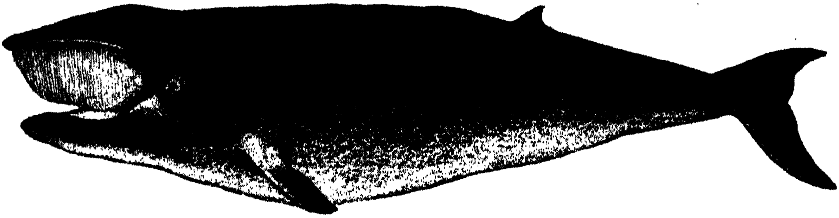

Fig. 2.—Pygmy Right Whale (*Caperea marginata*)

External Measurements, after Hale (12):—

Total length to middle of tail	10 ft. 10 in. (325 cm.)
Tip of snout to eye	21·5 %[1]
Tip of snout to origin of dorsal fin	66·9 %
Height of dorsal fin	3·8 %
Tip of lower jaw to origin of flipper	30·0 %
Length of flipper	10·8 %
Length of gape	20·0 %

Nothing is known of the habits of this form.

The Fin Whales

Family *Balaenopteridae*

Head less than one-fourth the length of the body. Dorsal fin present. Throat marked by numerous longitudinal furrows. Plates of baleen short and broad.

3. Blue Whale or Sulphur Bottom

Balaenoptera musculus (Linné, 1758)

Distribution. Worldwide distribution, but more abundant in the southern hemisphere, and particularly common in antarctic waters. Frequently found in pack ice. Recorded from Australian seas. This form undoubtedly frequents Tasmanian waters.

External Characters. This species is the largest of all whales. Maximum length, 29 m. (95 ft.), the female being slightly larger than the male, fully matured males being about 95 per cent. of the length of the mature females. Dorsal fin very small, and situated three-quarters of the way down the body. Ventral grooves 70-118 (average about 90). *Colour*, uniformly bluish-grey above with lighter mottlings, rather paler below, dark towards the tail. Inner surface of pectorals grey to white. *Whalebone*, coarse and short, entirely black or bluish-black. 270-395 (average 320) plates on each side. Largest plates in the largest whales are 85 cm. (34 in.) long and 60 cm. (24 in.) wide.

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[1] Throughout this paper measurements are given in percentages of the length from the tip of the snout to the tail notch.

EXTERNAL MEASUREMENTS. The following measurements, taken from Mackintosh and Wheeler (21, p. 276), are the mean measurements of several hundred specimens:—

	Male.	Female.
Tip of snout to posterior insertion of dorsal fin	75·33 %	75·18 %
Tip of snout to eye centre	20·21 %	20·14 %
Tip of snout to blowholes	17·59 %	17·71 %
Length of base of dorsal fin	4·51 %	4·26 %
Height of dorsal fin	1·30 %	1·23 %
Length of flipper (tip to axilla)	9·89 %	9·81 %
Greatest width of flipper	3·67 %	3·65 %

Proportion of head to body increases with age. Thus in a 12·2 cm. (40 ft.) whale the head (tip of jaw to eye) is 15·3 per cent. of total length, and in a 26·5 m. (87 ft.) whale the proportion is 21·2 per cent.

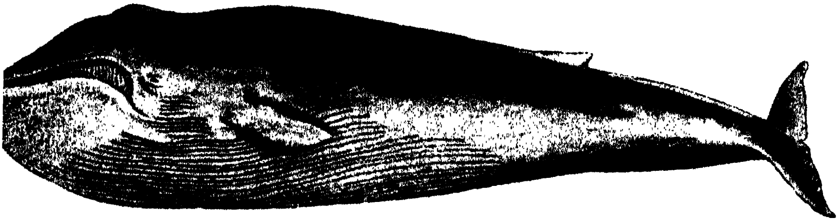

Fig. 3.—The Blue Whale (*Balaenoptera musculus*)

NATURAL HISTORY. This species spouts at intervals of 30 to 40 seconds. The spoutings are vertical and fairly dense and about 12 feet high. When the whale sounds it remains under water 30-40 minutes at the most. The female attains sexual maturity at an average length of 23·5 m. (77 ft. 2 in.) and the male at an average length of 22·5 m. (74 ft. 2 in.) (*International Whaling Statistics*, 1932). Average size at birth, 7 m. (23 ft.), sometimes as large as 8·2 m. (27 ft.). The sexes are about equal in number. The breeding season in the southern ocean is from May to September. Period of gestation, 11½ months. This species is of greater economic value than any other whale. Average yield of oil, 70 to 80 barrels, worth £360 to £400 (the record is 305 barrels). Wood-Jones (32, p. 276) states that the blubber is of poor quality, but Mackintosh and Wheeler (21, p. 272) emphasize the value of this whale, as the yield of oil is proportionately greater than in other whales; in fact, a higher price is paid to whalers for the capture of this species than for any other whale. Harmer (14, p. 109) states that when Blue Whales and Fin Whales are found together, as is usually the case, the former is the preferred object of the chase, as being the more productive animal.

4. THE FIN WHALE OR FINNER (RORQUAL)

Balaenoptera physalus (Linné, 1758)

DISTRIBUTION. Worldwide distribution. Fairly common in subantarctic waters. Does not usually frequent pack ice. No published record from Tasmania, but undoubtedly this species is found in Tasmanian waters and in Australian seas generally.

EXTERNAL CHARACTERS. Maximum length, about 25 m. (82 ft.). The females are larger than the males, the length of male being about 91 per cent. of that of the female. The general form of this whale is proportionately slimmer than that of the Blue Whale, and the pectoral fins are relatively smaller. *Colour*, dark-grey above, white below, the two colours gradually merging. More white colour on the right of underside of the head than on the left. Right lower jaw white, left grey. This asymmetry of colour is explained tentatively by Mackintosh and Wheeler (21, p. 354) as being due to the fact that this whale swims slightly on the right side while under water. Pectorals grey above, light below. *Whalebone*, dark-grey, striped longitudinally with yellowish-white in varying proportions, bristles variable in colour but generally greyish. Anterior third of whalebone on right side white. Number of plates on each side, 270-480 (average 360). The whalebone plates 40-80 cm. (16-32 in.) long, with a mean length of 65 cm. (26 in.), and a width equal to 60-70 % of the length. Ventral grooves 68-114 (average about 85).

EXTERNAL MEASUREMENTS. The following averages, taken from Mackintosh and Wheeler (21, p. 323), are based upon the measurements of a large number of specimens.

	Male.	**Female.**
Tip of snout to posterior insertion of dorsal fin	**75·55 %**	**75·17 %**
Tip of snout to eye centre	**20·87 %**	**21·00 %**
Tip of snout to blowholes	**18·86 %**	**18·94 %**
Length of base of dorsal fin	**6·00 %**	**5·65 %**
Height of dorsal fin	**2·50 %**	**2·39 %**
Length of flipper (tip to axilla)	**8·27 %**	**8·23 %**
Greatest width of flipper	**2·82 %**	**2·75 %**

NATURAL HISTORY. When the animal sounds it disappears for a maximum period of 10 to 15 minutes. The female attains sexual maturity at a length of 20 m. (66 ft.) and the male at a length of 19·5 m. (64 ft.). Proportion of sexes: males 55 per cent., females 45 per cent. Average size at birth is 21·3 feet. The breeding season in the Southern Ocean is from May to September. Period of gestation 11½ months. This whale is said to reach maturity in 6-8 years, is fully mature at 10 years, and is old at 27 years. Average yield of oil, 35 to 50 barrels.

5. THE LESSER PIKED WHALE

Balaenoptera acutorostrata, Lacépède, 1824

DISTRIBUTION. Apparently not a common form. Probably has a worldwide distribution. Found in high latitudes in pack ice in the southern summer. Found throughout the antarctic and subantarctic seas.

EXTERNAL CHARACTERS. This is the smallest species of the genus. Maximum size about 9·1 m. (30 ft.). Body relatively deeper than in other species of the genus. Head narrow and pointed; the upper jaw fits closely into the hollow of the lower jaw, which projects beyond the upper. Dorsal fin relatively high, the tip being strongly recurved. Flippers small. Body keeled dorsally and ventrally behind the dorsal fin. *Colour*, grey-black above, white below. Flukes grey above, white below. Flippers with white band on the outside. A triangular patch of lighter colour is generally present on either side of the back in the region of the dorsal fin. *Whalebone*, plates and bristles yellowish-white, average 325 plates on each side. Greatest length, 20 cm. (8 in.) without bristles.

EXTERNAL MEASUREMENTS of a female (after Turner, 30):—

Length	8·6 m. (28 ft. 4 in.)
Tip of beak to posterior insertion of dorsal fin	75·3 %
Tip of beak to blowholes	13·2 %
Length of base of dorsal fin	5·6 %
Height of dorsal fin	3·5 %
Length of flipper (tip to axilla)	9·3 %
Greatest width of flipper	3·8 %

NATURAL HISTORY. Little is known of the habits of this species. It probably has the same migratory habits as other species of the genus. Length at birth, about 2·7 m. (9 ft.).

6. THE SEI WHALE

Balaenoptera borealis (Lesson, 1828)

DISTRIBUTION. The natural home of this species is probably in the northern hemisphere. Its appearance south of the equator is spasmodic and its occurrence in the antarctic is rare. Lillie (18) records several specimens from the seas south of Australia in parallels 41° to 44° S. Some of these observations were made not far from the Tasmanian coast, so that we are justified in including this species in the Tasmanian list. There is no record of this whale having been washed ashore on the Australian coast, but specimens have been taken in New Zealand. It has also been recorded south of the equator from the Falkland Islands, South America, and South Africa.

EXTERNAL CHARACTERS. Comparatively small size. Greatest length, about 16·4 m. (54 ft.). Average length of mature animals, 14·3 m. (47 ft.). Females slightly larger than males. Dorsal large, high and falcate. Intermediate in general body proportions between the Blue Whale and Little Piked Whale. *Colour*, variable. Grey, with or without bluish tinge. Ventral surface lighter. The grey dorsal area sometimes continued into a ventral band across the abdomen. Ventral folds white or pink, with the furrows a deeper colour. Ventral furrows 32 to 60 in number. *Whalebone*, deep bluish-black, bristles grey or white, 290-340 on each side. Greatest length 77 cm. (31 in.), greatest width 30 cm. (12 in.).

EXTERNAL MEASUREMENTS (Andrews, 1):—

	Male.	Female.
Total length	14·5 m. (47 ft. 6in.)	14·6 m. (48 ft.)
Tip of snout to eye	18·9 %	20·1 %
Tip of snout to blowholes	15·4 %	16·6 %
Tip of snout to posterior insertion of dorsal fin	70·4 %	72·0 %
Height of dorsal fin	3·6 %	3·1 %
Length of base of dorsal fin	4·1 %	—
Length of flipper	9·0 %	8·9 %
Width of flipper	2·7 %	2·7 %

NATURAL HISTORY. This whale is now not so abundant as in former times, probably the result of overfishing. Strictly speaking, it is a northern form, and is said to migrate from the northern latitudes about September; it goes as far south as the sub-antarctic, and returns northward about May or June, remaining in northern waters during the summer (June to August). It is not unlikely, however, that many animals remain permanently in the southern hemisphere. The spout of the species is rather diffuse, and ascends vertically to a height of 10 to 14 feet. It blows once or twice a minute, or sometimes as frequently as every 20 seconds. It is said to be the fastest of the larger whales for short bursts of speed, for example, immediately after having been harpooned. It feeds upon *Euphausia* and the Copepod *Calanus finmarchicus*, but is said to feed also on sardines when these are present in the surface waters in large numbers. Period of gestation, 10-11 months.

7. THE HUMPBACK

Megaptera nodosa Bonnaterre, 1789

This whale has been given several names since it was described in 1789, partly because the northern and southern forms were considered to be distinct species. There appears to be no justification for such a distinction, and most authorities now regard the humpbacks of the world as belonging to one species.

DISTRIBUTION. Cosmopolitan. Recorded from all parts of the coast of Australia and from New Zealand.

EXTERNAL CHARACTERS. Maximum length, about 16·7 m. (55 ft.), though much larger animals have been recorded. The female is larger than the male, the average length of a mature male being about

90 per cent. of that of the mature female. The external form is very characteristic, and leaves no doubt as to the identity. The body is relatively much deeper than in *Balaenoptera.* The snout and mandible bear a number of hemispherical tubercles. The dorsal fin is low and thick. The flippers are long and narrow, exceeding in relative length those of all other whalebone whales, and the preaxial border of each fin bears a number of protuberances. The ventral grooves are few and broad, 14-30 in number. *Colour*, variable. Normally black on head, back, and sides, but frequently broken up by white lines or patches. The throat, chest, and undersurface generally entirely white, sometimes streaked with black. Flukes black above, white or spotted below. Flippers: upper surface black or streaked black and white, anterior edge white, posterior black, undersurface white. *Whalebone*, dull greyish-black, though some of the anterior plates may be white. Longest whalebone (without bristles), 61 cm. (24 in.). Greatest breadth, 12·5 cm. (5 in.). 400 plates on each side.

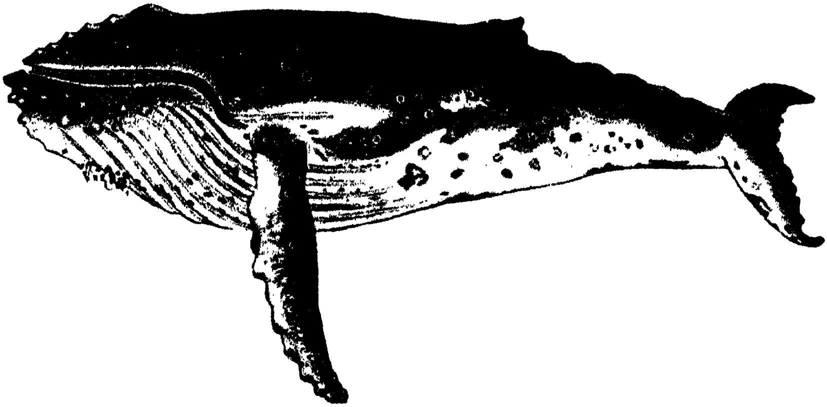

Fig. 4.—The Humpback (*Megaptera nodosa*)

EXTERNAL MEASUREMENTS, given by Chubb (3):—

	Female.	Male.
Total length (snout to notch in tail)	14 m. (46 ft.)	13·2 m. (43 ft. 6 in.)
Tip of snout to posterior insertion of dorsal fin	70·2 %	68·9 %
Tip of snout to eye centre	23·3 %	27·5 %
Tip of snout to blowhole	—	23·0 %
Vertical height of dorsal fin	3·2 %	2·8 %
Length of flipper from head of humerus	32·6 %	—

NATURAL HISTORY. The Humpback is somewhat slower in its movements than the various species of *Balaenoptera.* According to Lillie (18), it seldom stays under water for more than seven minutes. It shows a distinct partiality for coastal waters. The southern forms spend the summer in the Antarctic, and migrate northward towards sub-tropical waters in the winter. Thus this whale probably visits Tasmanian waters in the early winter during its northerly migration, and again in the spring on its way back to the Antarctic. The young are born in the warmer waters during the winter months. Period of gestation, about 11½ months. Size of young at birth 4·5 m. ([illegible] ft.). The females are more abundant than the males. This form is becoming less abundant. The beginning of the twentieth century saw the revival of antarctic whaling, and at first the humpback was almost the only whale which was hunted. In South Georgia, for instance, nine-tenths of the whales caught in 1911 were humpbacks In recent years, however, only a small percentage of the whales caught have been humpbacks.

According to Dakin (5, p. 238), a humpback yields an average of 35 to 40 barrels of oil. Crowther (4, p. 132) states that the yield was 6 to 7 tuns.[1]

In early days the humpback was principally hunted in the following parts of the southern seas: Indian Ocean (Mozambique, Madagascar, and N.W. Australia), Pacific Ocean (New Caledonia, Tonga Islands, New Zealand, Lower California, Galapagos, Coast of Chile), Atlantic Ocean (West Indies, Cape Verde Islands, Coast of Angola).

THE TOOTHED WHALES

Sub-order **Odontoceti**

The principal external characters of this sub-order are given above (p. 164).

With the exception of the Sperm Whale, the toothed whales have not the same economic importance as the whalebone whales. The former are, moreover, generally smaller than the latter, the Sperm Whale being the only member of the group which is known to attain the gigantic size of the larger whalebone whales. Unlike the latter, the males of the toothed whales are larger than the females. The presence of teeth accounts for the predacious character of most toothed whales, which generally feed upon fish. The enormous Sperm Whale, however, usually feeds upon cuttlefish, and the Killer Whale is said to be the only whale which will prey upon other whales. It also feeds upon seals and other aquatic mammals.

It cannot be said that our knowledge of the smaller dolphins is very satisfactory. Owing to their small size and negligible economic importance, together with their habit of frequenting the high seas, our precise knowledge of these forms is dependent upon the occasional strandings of specimens. The stranding of a dolphin of small size arouses little or no comment, and consequently only a small percentage of such animals come under the notice of specialists, and in most of these cases only the skeleton is available for examination.

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[1] One tun = 8 barrels.

Tasmanian representatives of the toothed whales may be divided into three families, as follows:—

1. Functional teeth present only in lower jaw. One pair of grooves on throat:
   - (i) Teeth numerous. Blowhole on left side of head. Single nasal passage. Mouth on lower side of head .... family *PHYSETERIDAE*
   - (ii) Teeth few. Blowhole median. Double nasal passage. Mouth terminal. Tail not notched .... family *ZIPHIIDAE*
2. Functional teeth present in upper and lower jaws. No grooves on throat. Tail notched .... family *DELPHINIDAE*

THE SPERM WHALES

Family *Physeteridae*

Members of this group may be distinguished as follows:—

1. Large size. Large, sharply truncated head. Blowhole at tip of snout. 22-26 pairs of large conical teeth .... *Sperm Whale*
2. Small size. Relatively small head. Blowhole at vertex of head. 13 pairs of small recurved teeth .... *Pygmy Sperm Whale*

8. SPERM WHALE OR CACHELOT

Physeter catodon Linné, 1758

It is considered by some that there are distinct northern and southern species, by others that there are two southern forms and one northern. Flower (8) considered that there was no difference between northern and southern forms, and that there is only one cosmopolitan species. This would appear to be the soundest view to take.

DISTRIBUTION. Worldwide, and recorded on many occasions from Australian and Tasmanian waters. A school of 36 males and one female was stranded on Perkins Island, North-West Tasmania, in February, 1911. Harmer (13) states that this species occurs in all tropical waters, but stragglers, nearly always old males, reach both polar seas.

EXTERNAL CHARACTERS. The size of this species has been greatly exaggerated. The male rarely exceeds 18·25 m. (60 ft.), the normal size being 12-15 m. (40-50 ft.), and the fully grown female is about 30 per cent. shorter. The Sperm Whale cannot be mistaken for any other whale owing to the enormous head and sharply truncated snout. The blowhole is single, as in all toothed whales, and is situated near the tip of the snout on the left side, and the 'spout' is directed forward. The dorsal fin is not well defined, and is represented by a series of humps. There are normally 22-26 pairs of teeth in the lower jaw. These teeth are large and conical. Generally there are no teeth in the upper jaw, but on rare occasions a few pairs of small irregular teeth are found. It was a favourite hobby [illegible]d-time whalers to engrave the teeth of the Sperm Whale with [illegible]s of ships, &c. The Tasmanian Museum contains a good [illegible] form [illegible]n of such 'scrimshaw' work brought back by Hobart whaler[illegible]r, black above, greyish below.

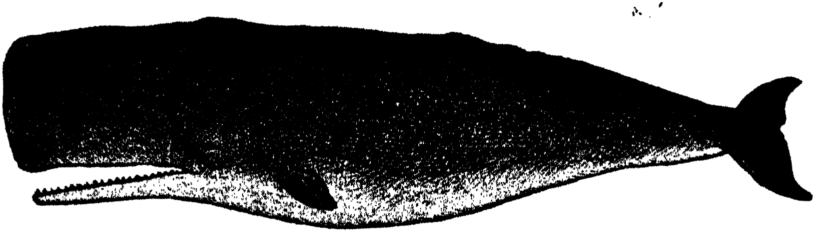

Fig. 5.—The Sperm Whale (*Physeter catodon*)

EXTERNAL MEASUREMENTS of a male (Chubb, 3):—

Tip of snout to notch of tail	16·4 m. (54 ft.)
Tip of snout to posterior insertion of dorsal fin	70·4 %
Length of base of dorsal fin	7·4 %
Tip of snout to eye centre	32·4 %
Tip of snout to anterior insertion of flippers	39·3 %
Length of flipper from head of humerus	8·9 %

NATURAL HISTORY. This species prefers the warmer waters, but passes into higher latitudes in the summer, and usually keeps to the high seas and avoids the land. As a rule, a school consists of several females with one or two males, so that the stranding of a school of whales in Tasmania, all of which, with one exception, were males, as referred to above, must be regarded as unusual. It feeds upon squids. According to an old log-book quoted by Dakin (5, p. 73), if the male is harpooned the cows will desert him. If, however, a cow or calf is harpooned the rest of the school will flock around the wounded whale. The Sperm Whale is very active in spite of its size. It sounds to a great depth, and is said to be capable of remaining submerged for an hour. At one time it was very abundant, and was hunted for its valuable spermaceti, but its numbers have been greatly reduced. The sperm oil is mixed with spermaceti, most of which is contained in the thickened anterior part of the head. This whale is also famous for its ambergris, a pathological concretion of the intestines, which is used in the manufacture of perfumery, and was formerly used as a medicine. According to Dakin (5, p. 238), large males have given as much as 120 barrels of sperm oil, and females averaged 15 to 20 barrels, valued at £250. One sperm whale actually yielded £1600 worth of oil in 1860. Log-book records dating from 1761 to 1920 show that, so far as the southern hemisphere is concerned, during the months April-September the majority of sperm whales were caught (*a*) in the South Pacific on the equator, also on the Vasquez Ground (sub-tropical) between New Zealand and Fiji, and on the Archer Ground (tropical) and on the Coast of Chile Ground (sub-tropical), off the South American coast; (*b*) in the South Atlantic, mainly on the Carroll Ground, off the African coast; (*c*) in the Indian Ocean, off the African coast, on various tropical and sub-tropical grounds, and the Coast of New Holland Ground, off Western Australia. During the months October-March the records are much more scattered, and show that this species passes southward during these months: (*a*) in the South Pacific still abundant on the grounds already mentioned, but also common to the south of New Zealand, at Chatham Island, also on the Middle Ground between Australia and New Zealand, and more abundant on the Coast of Chile Ground; (*b*) in the South Atlantic abundant down the coast of South America as far as the Falklands, on the Tristan Ground (lat. 35° S.) and Cape of Good Hope, and still abundant on the Carroll Ground; (*c*) in the Indian Ocean, around Zanzibar and Madagascar, and as far south as 40°, and West and South-Western Australia.

Crowther (4, p. 148) gives an interesting map showing the whaling grounds of the Hobart Town whalers. He also gives a detailed historical account of sperm-whaling in Tasmanian ships.

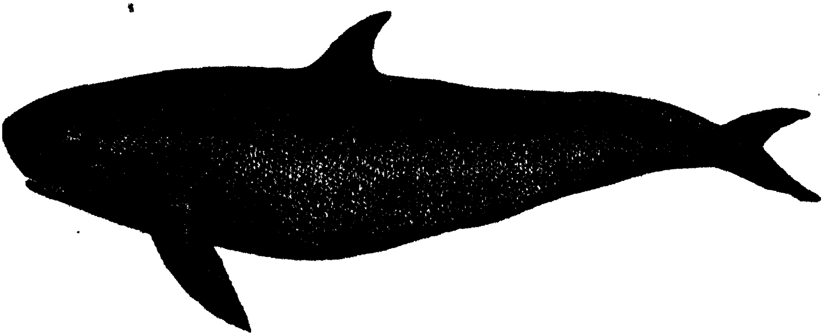

Fig. 6.—The Pygmy Sperm Whale (*Kogia breviceps*)

9. PYGMY SPERM WHALE

Kogia breviceps (Blainville, 1838)

Distribution. A rare form, but widely distributed throughout the world, particularly in the southern hemisphere. Not recorded from polar seas. Recorded from Tasmania.

External Characters. Maximum length, 4 m. (13 ft.). Average length of adult, about 2·7 m. (9 ft.). This species is rather delphinoid in appearance. It has a small head and slightly overhanging snout. Dorsal fin is well developed and falcate. The blowhole is single and placed slightly on the left of the middle line. There are about 13 curved teeth on each side of the lower jaw. Usually no teeth are present in the upper jaw, though there are a few cases on record of one pair being found at the front of the upper jaw. *Colour*, jet black above, white or pinkish-white below, the colours of the two surfaces being clearly separated.

EXTERNAL MEASUREMENTS, after Pearson (24):—

Total length to tip of tail	2·55 m. (8¼ ft.)
Tip of snout to tip of dorsal fin	50·6 %
Height of dorsal	7·4 %
Length of flipper	12·9 %
Tip of snout to front of eye	9 %
Distance between tips of flukes	21·9 %

Practically nothing is known of the natural history of this form.

THE BEAKED WHALES

Family *Ziphiidae*

Tasmanian members of this family may be distinguished as follows:—

1. Conical tooth at tip of lower jaw on each side, at the front of mouth	*Cuvier's Beaked Whale*
2. One tooth (laterally flattened) situated about half-way along the gape of the mouth, at each side:	
(i) Teeth strap-shaped in mature specimens, and grow upward around the beak	*Strap-toothed Whale*
(ii) Teeth triangular in side view	*Southern Beaked Whale*

10. CUVIER'S BEAKED WHALE

Ziphius cavirostris Cuvier, 1823.

Some authors regard the southern form (*Epiodon chathamiensis* Hector or *Ziphius novae zealandiae* Haast) as being a distinct species. The view taken here, however, is that there is one cosmopolitan species common to both northern and southern hemispheres.

DISTRIBUTION. A cosmopolitan species, which has been recorded from Australia, including Tasmania and New Zealand. It is probably not found farther south than 50° S.

EXTERNAL CHARACTERS. Maximum length, about 8·5 m (28 ft.). Delphinoid shape. Well-defined hump on posterior part of head, over the eyes. Eyes some distance behind the angle of the mouth. Lower jaw underhung and bearing one tooth at each side at the extremity. The teeth of the male are larger than those of the female. In some cases the teeth do not break through the gums. A number of small rudimentary teeth concealed beneath the gums have been recorded in both upper and lower jaws. One pair of grooves joining in front to form a V-shaped groove on the throat. Dorsal fin falcate and situated two-thirds of the distance down the back. *Colour*, head and anterior portion of back as far as dorsal fin, white; rest of body black. Dorsal fin black, except a narrow white line along the anterior edge. The division between the two colours is well marked except on the cheeks. The colour of this species appears to vary, and a specimen stranded in New Zealand was reported to be dark above and white below.

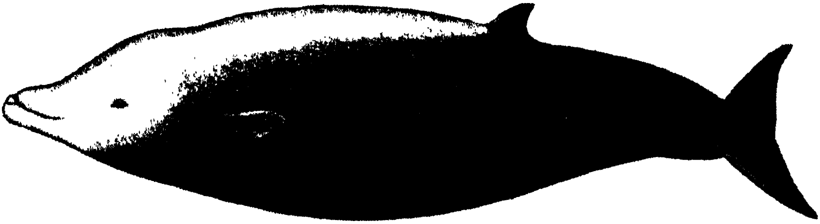

Fig. 7.—Cuvier's Beaked Whale (*Ziphius cavirostris*)

EXTERNAL MEASUREMENTS, after True (29).
Dimensions of a female whale 5·9 m. (19 ft. 4 in.) long.

Tip of snout to eyes	10·8 %
Tip of snout to blowhole	10·4 %
Tip of snout to axilla	20·0 %
Tip of snout to posterior margin of dorsal fin	67·2 %
Length of mouth	5·0 %
Length of flipper from axilla	8·1 %
Breadth of flipper	2·9 %
Vertical height of dorsal fin	5·2 %
Breadth of flukes	28·0 %

Nothing of importance is known of the natural history of this form. The beaked whales are related to the sperm whales, and have spermaceti.

11. STRAP-TOOTHED WHALE

Mesoplodon layardii (Gray, 1865)

DISTRIBUTION. This is a southern form, apparently rare, and has been recorded from Australian waters, New Zealand, Cape Colony, the Falkland Islands, and Tasmania.

EXTERNAL CHARACTERS. The only general description of this animal is given by Waite (31), from a specimen stranded near Lyttleton, New Zealand. Maximum length, about 5·5 m. (18 ft.). The dorsal fin is triangular, the posterior border being about vertical. There is a well-defined 'forehead' and a distinct beak. The most characteristic feature is the single tooth growing up on each side from the lower jaw about half-way along the gape of the mouth, arising from the mandible opposite the posterior end of the symphysis. These teeth grow upward and backward, and curve over the beak in old specimens (probably only in males), nearly meeting above, and thus preventing the mouth from opening to any extent. In immature specimens the teeth are short, and have a long antero-posterior axis. They are triangular in side view, the apex of the triangle being uppermost and forming the cutting surface of the tooth. The throat has one pair of grooves, widely separated behind and converging in front. *Colour.* From a point half-way down the back to the region immediately in front of the flippers there is a line surrounding the body in an oblique direction. Anterior to this line the body is yellowish-grey, with the exception of an irregular black band encircling the forehead and throat. Posterior to this line the animal is black, with the exception of a small greyish area on the ventral side and the tips of the fluke, which are yellow.

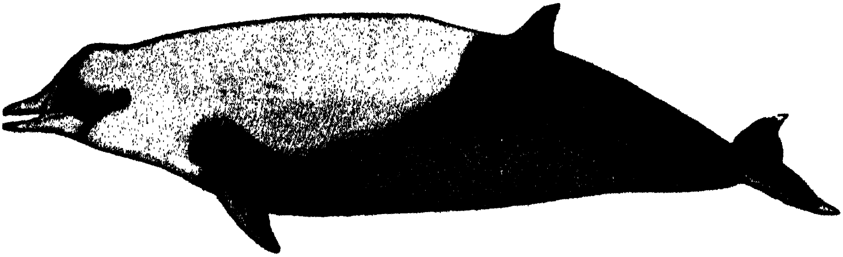

Fig. 8.—Strap-toothed Whale (*Mesoplodon layardii*)

EXTERNAL MEASUREMENTS of a male, given by Waite (31):—

Total length of animal	5·5 m. (18 ft. 3 in.)
Snout to blowhole	12·2 %
Snout to dorsal fin	60·8 %
Base of dorsal fin	8·2 %
Height of dorsal fin	5·9 %
Length of flipper	11·6 %
Width of tail flukes	26·5 %

Nothing is known of the natural history of this species.

12. SOUTHERN BEAKED WHALE

Mesoplodon grayi von Haast, 1876

DISTRIBUTION. South coast of Australia. Southern Pacific generally, including New Zealand and Patagonia.

EXTERNAL CHARACTERS. Snout pointed and beak-shaped. Flippers small. Dorsal fin falcate. A pair of grooves on the throat. A single tooth on each side of the lower jaw arising at the posterior end of the symphysis, having a position half-way along the gape of the mouth. This tooth is small in young specimens, and may be completely enclosed by the gum. In mature specimens it is large and triangular in side view and laterally compressed. In addition to these functional teeth there may be a series of 17-19 minute teeth on each side of the upper jaw. This row occupies a space of about

10 cm. (4 in.). These teeth are not attached to the maxillae, and come away with the tissues of the gum when these are removed. *Colour*, black all over, sometimes lighter below.

EXTERNAL MEASUREMENTS of a male, given by Hector (15):—

Total length	4·7 m. (15 ft. 6 in.)
Snout to eye	12·3 %
Snout to angle of mouth	8·1 %
Snout to flipper	20·9 %
Snout to dorsal fin	58·1 %
Snout to blowhole	11·3 %
Length of flipper	10·2 %
Height of dorsal fin	4·8 %
Base of dorsal fin	6·4 %

Nothing is known of the natural history of this form.

THE DOLPHINS

Family *Delphinidae*

The Tasmanian dolphins may be identified as follows:—

I. Teeth small. More than 20 on each side of both jaws:
  1. Three teeth in about 15 *mm.* (⅝-in.) of tooth line—
    (i) With dorsal fin:
      (*a*) Teeth 47-51 .... *Common Dolphin*
      (*b*) Teeth 35-44 .... *Slender-beaked Dolphin*
      (*c*) Teeth 28-34 .... *Dusky Dolphin*
    (ii) Without dorsal fin. teeth 35-44 .... *Péron's Dolphin*
  2. Three teeth in about 30 mm. (1¼ in.) of tooth line .... *Bottle-nosed Dolphin*
II. Teeth large. Less than 15 on each side of both jaws.
  1. Three teeth in 80-110 mm. (3¼-4⅓ in.) of tooth line. Head not globular:
    (i) Three teeth in 100-110 mm. (4-4¼ in.) of tooth line. Colour, black and white *Killer Whale*
    (ii) Three teeth in 80-90 mm. (3¼-3½ in.) of tooth line. Colour black .... *False Killer*
  2. Three teeth in 45-55 mm. (1¾-2¼ in.) of tooth line. Head globular .... *Pilot Whale*

13. THE COMMON DOLPHIN

Delphinus delphis Linné, 1758

DISTRIBUTION. Universal. Common in Australian waters. Flower (10) examined a series of skeletons from Tasmania, and stated that they were identical with the English form in every character.

EXTERNAL CHARACTERS. Average length, 2·1 m. – 2·4 m. (7-8 ft.). Body slender. Forehead sloping gradually. There is a distinct beak, which is separated by a groove from the upper part of the head. Dorsal fin triangular, slightly falcate, half-way down the back. Pectoral fin long and narrow. Teeth 46 to 51 on each side of both jaws. One tooth in every 5 mm. of tooth line. *Colour*, variable, generally black above, white or grey below (sometimes yellow in immature specimens). A curved black line outlined with white runs from the constriction of the beak to the eye. A curved line runs along the side of the body from the eye to the level of the hinder end of the dorsal fin. Above this line the animal is black, below it shades gradually from grey to white. Sometimes the light under-surface is streaked with dark curved lines.

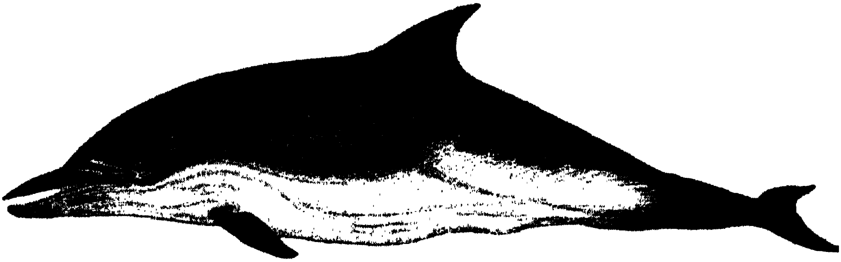

Fig. 9.—The Common Dolphin (*Delphinus delphis*)

External Measurements of a female (True, 28) :—

Total length	1·9 m. (6 ft. 4 in.)
Tip of snout to angle of mouth	14·5 %
Tip of snout to eye	16·5 %
Tip of snout to blowhole	18·5 %
Tip of snout to base of flipper	23·8 %
Tip of snout to dorsal fin	46·3 %
Length of flipper	15·2 %
Height of dorsal fin	9·3 %
Width of flukes	20·5 %

Natural History. This species is an active, powerful swimmer, and ascends estuaries for many miles from the open sea. It is frequently seen in large schools, which accompany ships on the high seas and play about near the ships' bows. This habit would appear to be common to many of the smaller toothed whales. The Common Dolphin is a fish eater. The stomach of a Mediterranean specimen contained over 15,000 otoliths of fishes. Scott and Lord (27) found the remains of cuttle-fish and Spatangoid spines. In some European countries the flesh of this dolphin is eaten. In Roman Catholic countries it is classed as a fish, and thus affords a welcome variation in the fish diet on fast days.

14. SLENDER-BEAKED DOLPHIN.

Stenella pseudodelphis (Schlegel, 1841)

Distribution. Temperate and sub-tropical seas of southern hemisphere.

External Characters. Similar to the Common Dolphin in general shape, and probably grows to same size. Teeth 35 to 44 on each side of both jaws. One tooth in every 5 mm. of tooth line. *Colour*, dark above, lighter below.

EXTERNAL MEASUREMENTS, from True (28):—

Total length (female)	1·75 m. (5 ft. 9 in.)
Tip of snout to dorsal fin	46·6 %
Tip of snout to base of flipper	23·0 %

Nothing is known of the natural history of this dolphin.

15. DUSKY DOLPHIN

Lagenorhynchus obscurus (Gray, 1828)

DISTRIBUTION. Southern seas as far south as 58° S. Recorded from New Zealand. A skull of this form is in the Tasmanian Museum.

EXTERNAL CHARACTERS. Maximum length, about 1·8 m. (6 ft.). There is a well-developed triangular dorsal fin about half-way down the body. This species is not unlike the Common Dolphin in external shape, except that the dorsal fin has a wider base and there is no distinct beak. Teeth small and numerous. 28-34 on each side of both jaws, commonest dentition 32. One tooth in every 5 mm. of tooth line. *Colour*, variable. Normally the back and fins black. (Sometimes the dorsal fin and flippers are white.) Ventral surface white, an oblique white area invading the dorsal black area immediately below the dorsal fin. Throat white, and this colour may also invade the upper lips. The two colours throughout the body are clearly separated from each other.

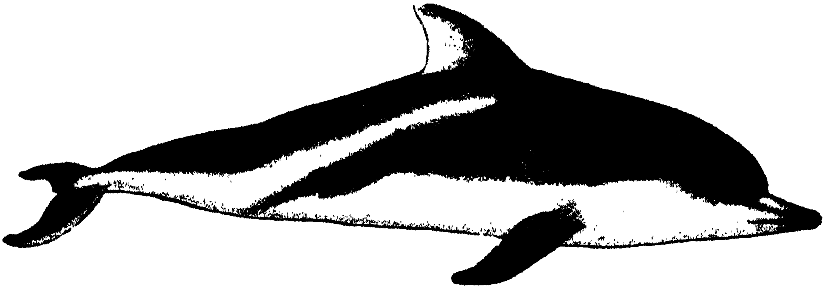

Fig. 10.—The Dusky Dolphin (*Lagenorhynchus obscurus*)

EXTERNAL MEASUREMENTS, after True (28), from a dried skin in the British Museum. The measurements may be regarded as only approximately correct.

Total length	1·6 m. (5 ft. 5 in.)
Tip of snout to angle of mouth	13·4 %
Tip of snout to eye	15·4 %
Tip of snout to blowhole	14·6 %
Tip of snout to anterior base of flipper	25·4 %
Tip of snout to anterior base of dorsal fin (along curve of back)	48·8 %
Length of dorsal fin	13·8 %
Height of dorsal fin	11·5 %
Length of flipper	16·9 %
Greatest width of flipper	5·4 %
Width of flukes	24·2 %

NATURAL HISTORY. Little is known of the habits of this form, but it occurs in large schools which play about the bows of ships, and so far as is known it is found only in southern seas.

16. PERON'S DOLPHIN

Lissodelphis peronii (Lacépède, 1804)

DISTRIBUTION. The few recorded observations of this species limit its distribution between 42° S. and 47° S. in the South Pacific and the seas around Tasmania. The first specimen was captured by Péron in 1802 to the south-west of Tasmania. The second specimen recorded from Tasmanian waters was seen in 1910 by the 'Terra Nova' expedition.

EXTERNAL CHARACTERS. This dolphin has two unmistakeable features, the absence of the dorsal fin and the peculiar colour. The lower jaw projects slightly beyond the upper. There is a groove separating the beak from the forehead, the beak being short and nearly in the same plane as the forehead. About 43 teeth on each side of both jaws. One tooth in every 5 mm. of tooth line. *Colour*. The back is black and the underside white, the separation between the two colours being very pronounced. The black area may or may not invade the tail-flukes.

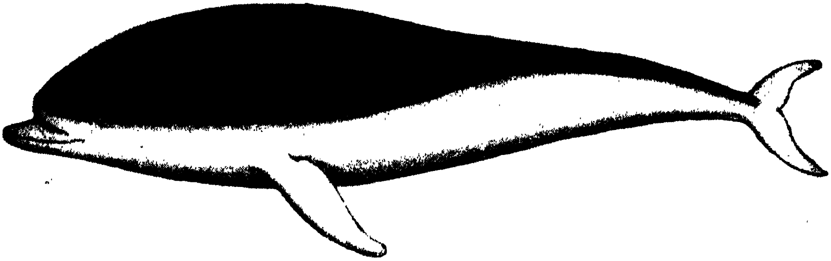

Fig. 11.—Peron's Dolphin (*Lissodelphis peronii*)

EXTERNAL MEASUREMENTS, from True (28), after Lesson.

Total length	1·84 m. (6 ft. 2 in.)
End of snout to flipper	32·3 %
End of snout to angle of mouth	14·7 %
Length of flipper	11·4 %
Breadth of flukes	23·5 %

NATURAL HISTORY. This species has been recorded only about half a dozen times, so that little is known of its habits. Lillie (18) records a pair of dolphins belonging to this species as having been seen playing under the bows of the ship. In one case they were in company with a school of Dusky Dolphins, but separate from them, and distinguished not only by their colour and absence of dorsal fin, but also by their larger size.

17. Bottlenosed Dolphin

Tursiops truncatus (Montagu, 1815)

This species was formerly known as *T. tursio*, a name which is now rejected in favour of the designation *T. truncatus*. Scott and Lord (26), though believing that the Southern Tursiops 'closely simulates that of European waters, and upon the whole justifies the retention of a single classification for both parts of the globe', at the same time suggest that the additional distinctive title of 'southern form' should be retained for this dolphin in southern waters. Such a proposal would not be in accordance with the International Rules of Zoological Nomenclature. If the 'southern form' is distinct it should be given definite specific or sub-specific rank. Iredale and Troughton (17), recognizing this, have established a new species, *T. maugeanus*, for Scott and Lord's southern form, but, as no diagnosis and no indication as to what characters distinguish it from *T. truncatus* have been published, *maugeanus* is a *nomen nudum*, and cannot stand. Until a complete examination of the 'southern form' has been made it would appear to be advisable to follow Flower (9, p. 481), who stated that the New Zealand form, which, presumably, is identical with the one from Tasmanian waters, differs neither in external appearance nor in its osteological characters from the European form.

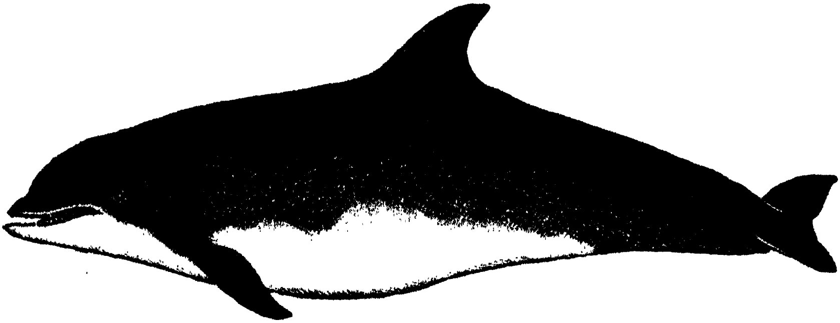

Fig. 12.—The Bottle-nosed Dolphin (*Tursiops truncatus*)

Distribution. Universal, ranging from northern temperate to southern temperate seas. Probably not found in polar seas.

External Characters. A large robust dolphin. Maximum length, about 3·0 to 3·3 m. (10-11 ft.), the females being about 10 per cent. shorter than the males. Lower jaw usually projects beyond upper jaw in the males. There is a well-developed, though short, beak. Forehead sloping. About 22-25 large teeth on each side of both jaws. Crown of tooth 17 mm. long, 8 mm. in diameter at the base. One tooth in every 10 mm. of tooth line. Dorsal fin in middle of back, high and falcate. *Colour*, back and head shining dark-grey or black. Underside white or light-grey, the upper and lower colours passing into each other by insensible gradations.

EXTERNAL MEASUREMENTS of a male, given by Flower (9).

Total length tip of snout to tail notch	2·9 m. (9 ft. 6 in.)
Tip of snout to angle of mouth	10·9 %
Tip of snout to blowhole	13·1 %
Tip of snout to anterior angle of eye	12·9 %
Tip of snout to anterior edge of dorsal fin	44·7 %
Length of flipper	13·6 %
Greatest breadth of flipper	5·3 %
Height of dorsal fin	7·9 %
Breadth of flukes	21·0 %

NATURAL HISTORY. Little appears to be known of the habits of this species. It is stated to ascend estuaries for a considerable distance. The related form *Tursiops catalania*, which is found off the Queensland coast, and may occur in Tasmanian waters, has very interesting habits, which it is stated have been utilized very cunningly by the aborigines. Longman (19, p. 276) has summarized the various accounts of this reputed co-operation. It is stated that the aborigines of Queensland are assisted by this dolphin, which frequents the inshore waters in shoals, in the capture of ' mullet '. The men sit on the sandhills overloking the bay. When a shoal of mullet is sighted the men rush down to the beach and splash the water with their spears. Upon this signal the dolphins drive the mullet inshore. The men enter the water with spears and hand-nets and a scene of confusion follows, in which fish, dolphins, and blacks are all mixed up together. The blacks leave the water when the nets are filled, and the dolphins are left to deal with the remaining fish. It is said that the dolphins will take a fish from the end of a spear when it is offered. The blacks claim that they know the individual dolphins, which become quite tame.

18. THE KILLER

Orcinus orca (Linné, 1758)

I do not propose to follow Iredale and Troughton (16) in assigning to this form the generic name *Grampus*.

DISTRIBUTION. Universal. Probably more common in colder waters.

EXTERNAL CHARACTERS. Grows to a size of 9 m. (30 ft.) in the male and 4·9 m. (16 ft.) in the female. The mature male has the largest dorsal fin of any whale, and may be as much as 1·8 m. (6 ft.) high. The male has relatively larger flippers than the female, and there is a record of a male Killer 9 m. (30 ft.) long, with a flipper 2 m. (6 ft. 8 in.) long and 1·1 m. (3 ft. 7 in.) wide. The flippers are broad and rounded. The teeth are large, and occupy practically the whole length of the gape of the mouth. There are generally 10 to 13 on each side of upper and lower jaws. One tooth in every 35 mm. of tooth line. The *colour* is very characteristic, with sharply defined black and white (or yellow) areas. The dorsal side is mainly black, but there is a small white patch on each side of the head immediately behind the eyes. There is usually a triangular white patch on each side of the body immediately behind the dorsal fin. The dorsal fin and flippers are black, the flukes black above and white below. The ventral surface has a well-defined white patch, with a wide anterior portion beneath the throat, narrowing behind the flipper, and dividing further back into two lateral areas situated at the sides of the body between the dorsal fin and tail.

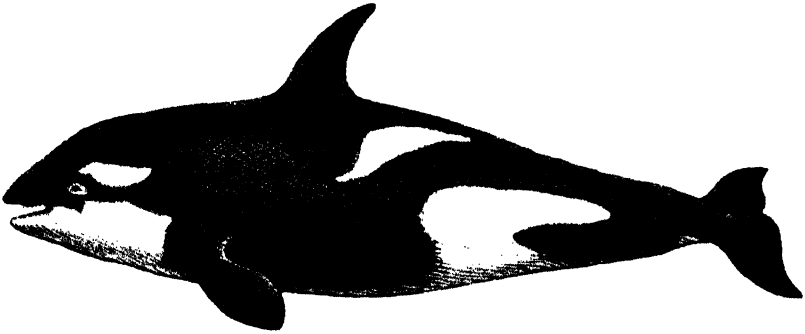

Fig. 13.—The Killer (*Orcinus orca*)

EXTERNAL MEASUREMENTS of a male, from Eschricht (7).

Total length	6·5 m. (21 ft. 4 in.)
Snout to angle of mouth	7·4 %
Snout to angle of blowhole	12·1 %
Snout to angle of dorsal fin	36·7 %
Snout to angle of base of flipper	16·8 %
Angle of mouth to eye	2·3 %
Length of flipper	18·3 %
Breadth of flipper	15 %
Height of dorsal fin	18·7 %
Length of base of dorsal fin	13·3 %
Distance between flukes	29·3 %

NATURAL HISTORY. The Killer is very powerful and active. It is the most predatory of all whales, and is said to be the only whale which preys upon other whales. A school of Killers will attack a large whalebone whale or sperm whale very much as a pack of hounds will tackle a deer. These predatory habits of the Killer whales were referred to by Pliny. Eschricht (7) reports that the stomach of a Killer contained 13 porpoises and 14 seals.

19. FALSE KILLER.

Pseudorca crassidens (Owen, 1846)

DISTRIBUTION. Cosmopolitan. Probably more abundant in subantarctic seas than elsewhere.

EXTERNAL CHARACTERS. Maximum length, about 5·8 m. (19 ft.). The males are much larger than the females. The head is obtuse. The flippers are small, narrow, and pointed, and relatively shorter than in the Killer. The dorsal fin is situated slightly in front of the middle of the body and is recurved. The teeth are similar in shape and disposition to those of the Killer. The number varies from 8 to 11 on each side of the upper jaw, and 8 to 12 on each side of the lower jaw. Usually there are more teeth on the lower jaw, and the commonest arrangement is $\frac{8}{10}$. One tooth in every 25 to 30 mm. of tooth line. *Colour*, black all over. Sometimes lighter below.

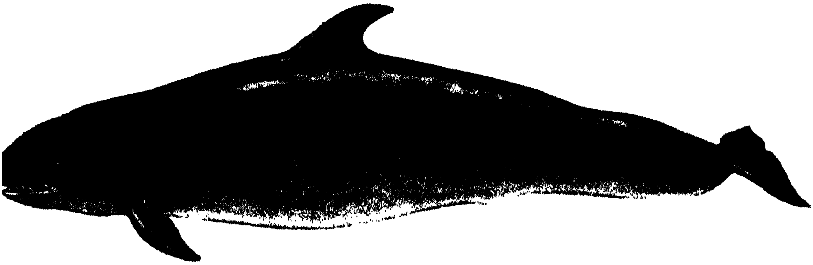

Fig. 14.—The False Killer (*Pseudorca crassidens*)

EXTERNAL MEASUREMENTS. I can find no records of external measurements. Fortunately, while this paper was in the press a school of False Killers was stranded near Stanley, N.W. Tasmania (June, 1936). Mr. E. O. G. Scott, of Launceston, visited the spot and made numerous observations, including measurements. I am indebted to Mr. Scott for the following measurements of three males, varying from 2·79 m. (9 ft. 2 in.) to 4·65 m. (15 ft. 3 in.), and two females, 2·51 m. (8 ft. 3 in.) and 2·67 m. (8 ft. 9 in.), in length. These measurements show that there is considerable variation in the proportions of the body.

	Males.	Females.
Tip of snout to eye	8·2—11·8 %	9·9—13·1 %
Tip of snout to blowhole	9·6—12·4 %	11·7—12·3 %
Tip of snout to base of flipper	14·5—19·6 %	15·3—21·4 %
Tip of snout to posterior margin of dorsal fin	51·2—62·0 %	63·2—71·7 %
Length of base of dorsal fin	15·2—15·7 %	13·8—14·7 %
Height of dorsal fin	8·3— 8·6 %	7·4— 8·3 %
Length of flipper	11·8—13·2 %	11·5—12·6 %
Greatest breadth of flipper	4·7— 5·0 %	4·6— 5·0 %
Distance between flukes	24·0—24·4 %	20·9—21·4 %

NATURAL HISTORY. This whale was first described by Owen in 1846, from a skull found in a sub-fossil condition in the Lincolnshire fens. Fifteen years later it appeared in the flesh on several occasions in the Baltic, and provided Reinhardt (25) with material for a monograph, in which he assigned the False Killer to a new genus, *Pseudorca*. Most subsequent writers have accepted this generic distinction, though the points in which the Killer and False Killer differ are not very great, and it is doubtful if there is justification for placing these two forms in separate genera. Since its first discovery this species has been recorded from various parts of the world. It occurs in large schools consisting of several hundreds of individuals, and on many occasions more than one hundred specimens have been stranded. In the southern seas it is probable that, in common with most whales, the False Killer migrates into warm tropical and sub-tropical waters in the breeding season (winter), and returns southward in the summer. It is interesting to note that the first record of this species from the southern hemisphere was based upon the Tasmanian specimens sent to the Royal College of Surgeons in 1864 by Dr. W. L. Crowther, of Hobart Town, and described by him as the Blackfish. It is not unlikely that Tasmanian whalers used this term for two distinct forms, the False Killer and the Pilot whale.

20. PILOT WHALE

Globicephalus melas (Traill, 1909)

Iredale and Troughton (16) have given reasons for concluding that Lacépède's *Delphinus ventricosus*, established in 1804, referred to the Pilot Whale. If they are right the specific name *ventricosus* would have priority over *melas*. I am not convinced, however, that their case has been established, and I propose, therefore, to retain the name by which this form is generally known.

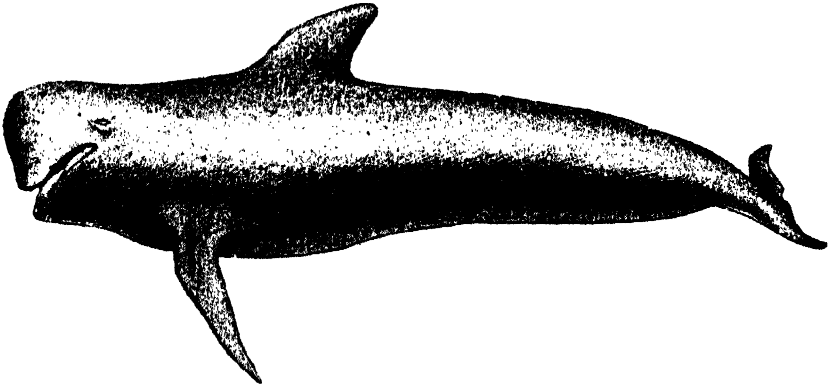

Fig. 15.—The Pilot Whale (*Globicephalus melas*)

DISTRIBUTION. Universal in tropical, temperate, and sub-polar seas.

EXTERNAL CHARACTERS. May reach a length of 8·5 m. (28 ft.). It is easily recognized by the shape of its head and the length of the flippers. The head is swollen in front, where it is almost globular.

It overhangs the upper jaw, which forms a very short beak. The flippers are relatively much longer than in any other toothed whale. The dorsal fin is well developed, and is in the anterior half of the body. The number of teeth is very variable. Normally there are about 10 teeth on each side of both jaws, with a maximum of 13 on the upper and 11 on the lower, according to Mr. E. O. G. Scott's observations. One tooth in every 15 to 18 mm. of tooth line. *Colour*, variable, generally described as black all over, with a small amount of white on the under-side. The white (or greyish-white) of the under-surface usually consists of a broad patch under the throat, which sends lateral extensions to the two flippers and a narrow median extension backwards to join a large area which reaches the posterior third of the body.

EXTERNAL MEASUREMENTS. The following measurements were made from specimens which were stranded at Stanley, North-Western Tasmania, in October, 1935.[1] The measurements are given in percentages of the total length.

	Male.	Female.	Female. Foetus.
Total length to caudal notch	3·87 m.	3·88 m.	1·02 m.
Tip of snout to vent	59·4 %	62·3 %	65·6 %
Tip of snout to base of flipper	16·2 %	16·6 %	20·4 %
Tip of snout to front edge of dorsal fin	20·2 %	30·5 %	39·0 %
Tip of snout to blowhole	10·1 %	9·5 %	10·2 %
Length of mouth cleft (measured along the mouth)	8·0 %	8·6 %	8·1 %
Length of flipper	16·9 %	18·8 %	22·9 %
Breadth of flipper	1·8 %	5·3 %	5·8 %
Height of dorsal fin	5·4 %	6·1 %	6·8 %
Width of flukes	20·4 %	19·5 %	18·5 %

A comparison of the foetal with the adult measurements shows that in the younger stages the anterior half of the body is proportionately larger than in the older stages. This is shown, for example, in the comparisons of the length from the snout to vent and in the length of the flippers.

NATURAL HISTORY. This species travels about in large schools. Beddard (2, p. 281) has given a good account of the method of capturing this species. This whale has been fished for many centuries in the northern hemisphere. When a school is sighted the fishermen put out to sea in numerous boats, with the object of driving the whales ashore. Hence the Scottish vernacular term 'Caa'ing whale', which means 'driving whale'. According to Beddard, an average whale gives 1½ barrels of oil, valued at £3 7s. 6d. The meat is dried and pickled, and the stomach is dried and made into buoys.

A large school of nearly 300 Pilot Whales was stranded near Stanley, North-Western Tasmania, on 14th October, 1935. Mr. E. O. G. Scott, B.Sc., of the Queen Victoria Museum, Launceston, accompanied by Mr. Cunningham, of the Tasmanian Museum and Art Gallery, Hobart, visited the spot, and I am indebted to Mr. Scott for the information I have given regarding measurements and colours. The sex of 194 individuals was determined by Mr. Scott, 80 being males and 114 females. Detailed measurements of 20 specimens were made by Mr. Scott. The largest specimen measured was about 6·1 m. (20 ft.) long. It is hoped that a detailed account of Mr. Scott's observations will be published in the next issue of this Journal.

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[1] The measurements of the two adults are taken from very copious notes made by Mr. E. O. G. Scott, to whom I am also indebted for the details of the colour of this species, as well as for other information.

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The Royal Society of Tasmania

Annual Report
1935

The Council and Officers

The annual meeting was held at the Society's Rooms, Tasmanian Museum, Hobart, on the 11th March, 1935.

The following were elected as members of the Council for 1935:—Mr. S. Angel, Mr. H. Allport, Mr. W. H. Clemes, Dr. W. L. Crowther, Mr. V. V. Hickman, Dr. A. N. Lewis, Hon. L. M. Shoobridge, Mr. E. E. Unwin, Mr. F. E. Ward.

His Excellency the Governor nominated the following members as Vice-Presidents:—Mr. W. H. Clemes, Mr. F. E. Ward.

The Council at its first meeting made the following appointments:—

Chairman of the Council: Mr. W. H. Clemes.
Secretary: Dr. Joseph Pearson.
Hon. Treasurer: Mr. S. Angel.
Standing Committee: Mr. Unwin, Dr. Lewis, and Dr. Pearson.

Representatives of the Society on the Board of Trustees of the Tasmanian Museum and Botanical Gardens:—Mr. W. H. Clemes, Dr. W. L. Crowther, Dr. A. N. Lewis, Mr. S. Angel, Mr. E. E. Unwin, Hon. L. M. Shoobridge.

Meetings

Nine meetings have been held during the year, and in addition to the lectures delivered, scientific papers of considerable value and interest were submitted for publication.

(See abstract of meetings for abstracts of lectures, papers, &c.)

Library

The Society's library still continues to be of service to members and others desiring scientific and historical information. A number of new volumes has been added to the various sections during the year. In December, 1934, the number of books totalled 17,969, and in December, 1935, 18,254, showing that 285 volumes have been added during the year.

Mrs. Clive Lord was appointed Assistant-Librarian in November, 1933, and has continued to act since that date. In consequence it has been possible to reorganize the Library and to make a complete rearrangement of the books on the shelves, and the Library has benefited considerably by Mrs. Lord's services.

Owing to congestion in the Library it was found imperative to obtain new book-cases. As no Society funds were available, an appeal was made to members, with the result that £11 11s. 6d. was obtained. In addition one member paid a life membership subscription (£15) in order to assist this project. The Council decided to utilize this life membership fee for this special purpose. Thus the Council was enabled to provide two new book-cases.

Membership

The membership for the year, compared with that of 1934, is as follows:—

	1934.	1935.
Honorary members	4	4
Corresponding members	5	4
Life members	6	7
Ordinary members	245	229
Total	260	244

During the year 38 names were removed from the membership owing to deaths, resignations, &c., and 22 new members were added.

The Council regrets to have to record that the following members have died during the year:—

Mr. J. M. Bowling.
Mr. W. T. Gellibrand.
Mr. W. Graham.
Mr. J. E. C. Knight.
Sir N. E. Lewis, K.C.M.G., M.A., B.C.L., LL.B.
Dr. R. Pulleine.

Papers and Proceedings

The Government has again assisted with the printing of the Papers and Proceedings, and this concession is greatly appreciated by the Council.

Abstract of Proceedings
1935

11TH MARCH, 1935

Annual Meeting

The annual meeting was held at the Society's Rooms, Tasmanian Museum, on this date. In the absence of the President, His Excellency Sir Ernest Clark, K.C.B., C.B.E., Mr. W. H. Clemes presided.

The following were elected as members of the Council for 1935:—Mr. H. Allport, Mr. S. Angel, Mr. W. H. Clemes, Dr. W. L. Crowther, Mr. V. V. Hickman, Dr. A. N. Lewis, Mr. F. E. Ward.

The President not being present, the appointment of the new Vice-Presidents was deferred until next meeting.

Mr. Walter E. Taylor was appointed Hon. Auditor.

The following members were elected:—Miss E. Atkinson, Mr. J. H. B. Ewart.

Mr. R. W. Legge presented to the Tasmanian Museum, through the Royal Society, the skull of a juvenile Tasmanian aboriginal. Presentation to the Society was also made by Mr. S. K. Johnstone of a list of historical references to ships and seafaring men sailing from Hobart in the old days.

Mr. E. E. Unwin, M.Sc., gave an illustrated lecture on 'The Breathing of Animals', of which the following is an abstract:—

> Oxygen is one of the primal needs of all living organisms. The vast majority obtain this oxygen for the fires of life from the gas in the air or dissolved in the water.
>
> The story of the breathing of animals is the story of adaptation, and is one of the chapters in the story of evolution.
>
> The main story begins with simple forms breathing through the surface in contact with water, and goes on to the acquisition of gills—special thin-walled organs developed in relation to a blood circulation, with oxygen storage media.
>
> The stories of isopods and insects were dealt with more fully, as they show the wonderful adaptability of creatures to a change in their normal environment.
>
> The breathing of the mollusca, fishes, frogs, birds, and mammals was dealt with in brief outline, giving some idea of the gradual change from aquatic to aerial life, and the increasing complexity and more active life demanding more efficient breathing arrangements.
>
> The lecture was illustrated by about 80 slides.

8TH APRIL, 1935

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

Under Rule 3 His Excellency the President nominated the following two Vice-Presidents:—Mr. W. H. Clemes, Mr. F. E. Ward.

The following members were elected:—Mrs. J. Pearson, Mr. C. E. Radcliff, Mr. J. W. Evans, Mr. John Reynolds, Mr. Wilfred Hudspeth, Mr. F. E. Wallace.

Mr. W. H. Hudspeth delivered an illustrated lecture entitled 'The Experiences of a Settler in the Early Days of Van Diemen's Land.' (See this Volume, p. 139.)

13TH MAY, 1935

A meeting was held in the Society's Rooms, Mr. W. H. Clemes presiding.

The following members were elected:—Mr. E. Parkes, Mr. D. A. McNeice.

Mr. K. M. Dallas, B.Com., gave a lecture entitled 'The Study of Economic Science,' of which the following is an abstract:—

THE STUDY OF ECONOMIC SCIENCE

'Economics is a branch of Biology, broadly interpreted.' (Alfred Marshall.)

Economic Science studies certain *aspects* of human behaviour—more particularly the manner in which Value measures human motives—or 'human behaviour as a relationship between Ends and Scarce Means which have alternative uses.' (Lionel Robbins.)

The current notion that Economics is concerned with a narrow materialism, with Man and his acquisitive instincts, with discovering laws based on self-interest of an Economic Man, is one hundred years behind the present development of the Science. The definition given shows that the science is concerned with certain *aspects* of all social phenomena, not with a separate body of facts. All social sciences study the same facts, but in different aspects or relationships. 'The Economist must also be "philosopher, mathematician, politician, historian"—in some degree.' (J. M. Keynes.)

The central concept of the Science is Value. Two centuries of deductive reasoning, approaching the concept from the angles of Cost of Production and from Utility, and Final or Marginal Utility, have gone to the building of an organon or method of reasoning—not a body of final, concrete truth, but an engine for the discovery of concrete truth. The theory of Value must suffice to explain the human motives behind all such phenomena as prices, wages, interest, rent; behind saving, spending, lending, borrowing. The economist specializes in the study of certain aspects of these phenomena, those aspects dealing with use of Scarce Means to attain Ends which are either social and collective or individual, but is not unaware that these aspects are influenced by motives, religious, political, altruistic—motives which may cause scarce means to be applied in ways which are wasteful and uneconomic from a narrow material point of view.

The 'laws' of Economic Science are statements of 'tendency' expressed in the indicative mood. Their importance is always *relative* to the circumstances of place or time, and to the strength or weakness of other motives, other aspects than those of Value,—of Ends and Scarce Means.

In this broad sense the Generalizations of Economics are valid alike for the solitary Crusoe, the society of private profit and enterprise, the ordered, regimented society of Soviet Russia, and for the never-to-be-realized classless state of Communism, in which the 'State shall wither away,' and want, sin, and suffering shall be no more.

10TH JUNE, 1935

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

The following member was elected:—Miss C. Jensen.

Mr. E. O. G. Scott delivered an illustrated lecture entitled ‘Some Aspects of the Study of Tasmanian Fishes,’ of which the following is an abstract:—

> In the course of a general review of the subject, the speaker dealt with six aspects, as follow. (*a*) *Definitions*.—General preliminary remarks were based on lantern slides illustrating the various connotations of the word ‘fish,’ external features, outline of classification, and scope (by families) of the Tasmanian fauna relative to the Australian. (*b*) *History*.—Tribute was paid to the work of the late Clive Errol Lord, whose memory they were met that evening to honour; and the history of ichthyology in Tasmania briefly traced successively through the periods 1642-1803, 1804-1833, 1834-1842, 1832 to the present time. (*c*) *Commercial*.—The backward positions of Australia and of Tasmania relative to other States were made evident by slides showing relative value of Australian production, number of ships, value of production (total, and *per capita*) in States, consumption per head, value of imports and exports. Observations were made on the commercial clupeoid fishes, and the vast possibilities of our pelagic fisheries indicated. (*d*) *Sporting*.—The history of the introduction of Salmonidae to Tasmania was briefly recalled. The urgent need for a proper scientific investigation of our fisheries was emphasized, and some general remarks were made on the individual problems presented by our lakes and rivers, and on such relevant ecological factors as animal communities, ecological gradient and succession, daily and seasonal rhythms, and food-chains. Slides were shown illustrating the correlation of physical and chemical factors of the environment with one another and with fish-food and fish, longitudinal distribution in accordance with physiographical conditions, rapids community, food-cycle in small lake, principal items of trout-food, trout leaping falls, large rainbow trout. (*e*) *Methods of Research*.—Some general observations on the nature, distribution, and special problems of the Galaxiidae, or native trout, were followed by some remarks on the speaker's investigations on the family. Slides shown included methods of trapping, characteristics of Galaxiid genera, diagnostic features of species, local distribution (with incidental notes on chief Tasmanian zoogeographic regions), graphs of scope of Tasmanian Galaxiid fauna, rate of growth, ability to survive out of water, &c. (*f*) *General*.—A series of slides was shown, illustrating some interesting and peculiar fishes, chiefly from Tasmanian waters.

At the conclusion of the meeting His Excellency the Governor unveiled a memorial tablet in the Museum to the memory of the late Clive E. Lord. Dr. Crowther and Dr. Lewis spoke, and expressed their tribute to the memory of Mr. Lord.

8TH JULY, 1935

A meeting was held in the Society's Rooms, Mr. F. E. Ward presiding.

Mr. W. E. Maclean delivered an illustrated lecture entitled ‘Hydro-Electric Developments in Tasmania,’ of which the following is an abstract:—

> The lecturer referred to the demand for electrical power which arose both during and after the Great War. This demand grew at such an amazing rate that the great industrial nations were compelled to take stock of their power resources, particularly as power development was of vital importance to the proper economic development of the world. Electricity has changed the whole economic future of industry because of three important factors:
>
> 1. It supplies a motive power cheaper and more elastic than any other type.
> 2. It is more efficient than steam or gas, and has led to a reduction in fuel consumption per unit of manufacture.
> 3. It is capable of more diversified use than any other form of power, and can be automatically controlled.

The lecturer then discussed the problem of securing the uniform consumption of power to enable the authorities to sell its energy at a low price.

In 1929 the survey of the potential waterpower available in Australia for hydro-electric services showed that 74 per cent. of this potential waterpower was located in Tasmania. Tasmania had 7000 horsepower per thousand of population; a figure only exceeded by the Belgian Congo and the Belgian Mandated Territory in West Africa, with 8000 horsepower per thousand.

The State has many of the raw materials used in industry, such as copper, lead, zinc, and limestone; and the supply of timber for pulp and paper making is almost unlimited. With the advantage of a cheap electric power supply at hand, no opportunities should be lost of developing these industries.

Since 1914, when the Hydro-Electric Department came into being, several important contracts have been made for bulk supplies of power to important industries. Extensions have been made to country towns and municipalities. The Waddamana plant has ben enlarged from 10,000 to 66,000 horsepower, and the Shannon Station of 12,000 horsepower has been completed. The latest development was that the third unit of the State's hydro-electric system was now being built, and it would add 66,000 to the 78,000 already existing.

The lecturer concluded by showing a series of slides of various sections of the hydro-electric works at the Great Lake, Waddamana, Tarraleah, and elsewhere.

12TH AUGUST, 1935

A meeting was held in the Society's Rooms, Mr. W. H. Clemes presiding.

The following members were elected:—Mr. George Dick, Mr. Gilbert McKinley, Mr. Basil Rait.

Dr. Joseph Pearson delivered an illustrated lecture entitled 'Heredity,' of which the following is an abstract:—

The lecturer summarized our present knowledge of the physical basis of heredity. The elements of germ plasm known as genes are responsible for the characteristics of an organism. Just as the genes are handed on from generation to generation as units which do not lose their identity, so the characters produced by them remain unchanged though they may be suppressed. Thus, maternal and paternal characteristics which are handed on to the child do not become blended. For example, the offspring of a homozygous blue-eyed father and a homozygous brown-eyed mother will be heterozygous brown-eyed, although their cells will also carry the genes for the blue-eyed character. In this case brown is dominant, and blue is hidden or recessive. Each heterozygous brown-eyed offspring will have ripe germ cells of two kinds, one half carrying the genes for blue and one half carrying the genes for brown. This bears out the phenomena described by Mendel. The existence of incomplete dominance is presented by Andalusian fowls, the well-known blue Andalusian being a hybrid produced from a homozygous white and a homozygous black.

With regard to sex, it is found that normally in the female two X-chromosomes are present, whereas in the male there is only one X-chromosome. When the germ cells become mature each egg will be found to contain one X-chromosome, while only one-half of the male germ cells will contain an X-chromosome. Thus, if an egg is fertilized by a sperm containing an X-chromosome, a female is produced, but if by a sperm lacking the X-chromosome a male will be produced. Like the ordinary chromosomes, the X-chromosomes bear genes. These genes will, therefore, follow the sex, and thus we have sex-linked characters, which are of great importance to breeders of domestic animals.

In human beings, colour-blindness is sex-linked. If the mother is colour-blind and the father normal, all the sons will be colour-blind and all the daughters normal. On the other hand, if the father is colour-blind and the mother normal, all the offspring will be normal, though all the daughters will be 'carriers,' and will be capable of handing on the defect in the next generation.

The lecturer concluded by indicating how the discoveries of the physical basis of inheritance might be applied to human genetics and eugenics.

9TH SEPTEMBER, 1935

A meeting was held in the Society's Rooms, Mr. F. E. Ward presiding.

The following members were elected:—Mr. G. S. Carruthers, Mr. E. R. Hudson.

Mr. V. V. Hickman gave an illustrated lecture entitled 'The Cryptozoic Fauna of Mount Wellington,' of which the following is an abstract:—

THE CRYPTOZOIC FAUNA OF MOUNT WELLINGTON

The cryptozoic fauna of Mount Wellington is rich and varied, but apart from the Insecta very few of the animal groups comprising the fauna have received much attention from students.

Sixteen Land-planarians have been recorded from Tasmania, and six of these are known to occur under logs and stones on the mountain. The most common species is *Geoplana tasmaniana*, which was first discovered by Charles Darwin, when he visited Tasmania in H.M.S. *Beagle* during February, 1836. This planarian has the shape of a narrow leaf, about 35 mm. long. Another species often found at the Cascades is *G. typhlops* Dendy, which grows to a length of 220 mm. It is our largest land-planarian, and is quite blind. Its black oval egg-capsules measure 10 x 5 mm., and are made during August and September. Other species found on the mountain are *G. diemenensis* Dendy, *G. mortoni* Dendy, *G. quinquelineata* Fletcher and Hamilton, and *G. nichollsi* Dendy.

Associated with the Geoplanarians is an interesting Land-nemertean, which appears to be a Tasmanian variety of the Victorian *Geonemertes australiensis* Dendy. When disturbed it shoots out a long proboscis, which functions not only as a weapon of defence, but also as an aid to rapid locomotion, for the Nemertean is able to pull itself along by means of the organ.

Terrestrial Mollusca are well represented on Mount Wellington. Five species belong to the genus *Flammulina*, and three to *Endodonta*, whilst single species belonging to the genera *Caryodes*, *Rhytida*, *Delos*, and *Helicarion* have also been recorded from the mountain. The largest species is the Mountain Snail, *Caryodes dufresni* Leach. The Thrush, *Geocichla macrorhyncha* Gould, feeds largely on this snail. The most common snail is the beautiful *Helicarion cuvieri* Ferrussac. It has a yellowish-brown shell, which is glassy and transparent.

Tasmanian Oligochaeta have not received the attention which they deserve, and the mountain offers a fruitful field for research in this group. The Hirudinea are represented by the little land-leech, *Philaemon pungens* Blanchard. It is not a strictly cryptozoic animal. During the winter, however, it hides under logs, and in November and December makes its egg capsules. These are rounded, and have a honeycombed outer surface. The young leeches emerge from the capsules in March and April.

Twelve Centipedes have been recorded from Tasmania. Those which occur under logs and stones on Mount Wellington are usually long, slender species, of a yellow or reddish colour. They are blind forms, belonging to the Geophilomorpha, the most common species being *Pachymeroides alter* Chamberlin and *Pachymerellus zygethus* Chamberlin. The Lithobiomorpha are represented by *Henicops maculatus* Newport. There are ten Diplopods reported as occurring in Tasmania. Three species are frequently met with on the mountain, namely, *Amastigogonus tasmanianus* Brolemann, *Tasmanodesmus hardyi* Chamberlin, and at higher altitudes a member of the genus *Procyliosoma*, which has the habit of rolling itself into a ball like an Isopod.

One of the most abundant members of our cryptozoic fauna is the terrestrial Amphipod, *Talitrus sylvaticus* Haswell, which is found from the foot to the summit of the mountain, and usually occurs in moss or among fallen leaves. The Isopod *Oniscus punctatus* Thomson is also plentiful.

The dominant group of cryptozoic animals is the Arachnida, which includes Spiders, Mites, Harvestmen, Scorpions, Pseudoscorpions, &c. All of these groups are well represented on Mount Wellington, but very few of the animals belonging to them have been studied. The most interesting spider on the mountain is the Cave Spider, *Ectatosticta troglodytes* (Higgins and Petterd). Under stones along the banks of the New Town Creek, where it flows down the mountain, the little spider *Symphytognatha globosa* Hickman makes its conical egg-sac. The female of this species is unique in lacking the tactile appendages or pedipalps.

The only scorpion known to occur on the mountain or elsewhere in Tasmania is the familiar *Cercophonius squama* (Gervaise).

Twelve Harvestmen or Opiliones have been recorded from this State. Of these, *Peckhamius pectinatus* (Pocock), *Lomanella raniceps* Pocock, and *Pantopsalis tasmanica* Hogg are frequently found in the gullies of Mount Wellington.

The cryptozoic Insects of the mountain have probably received more attention from students than is the case with other groups. Stag-bettles belonging to the genus *Lissotes* are often found under logs. Carnivorous Carabids are also plentiful, a large shining black species, *Percosoma carenoides* White, occurring at the Cascades. On the summit of the mountain the little black earwig *Euboriella tasmanica* Bormans is not uncommon under stones.

To the biologist one of the most interesting cryptozoic animals on the mountain is *Ooperipatus insignis* Dendy. The animal somewhat resembles a small caterpillar and has fourteen pairs of short legs. It captures its prey by means of an entangling sticky secretion, ejected with considerable force from two apertures, one on each side of its head. This little animal has survived from a remote age, and has retained many primitive features in its anatomy, which help us to bridge over the interval between the Annelids and the Arthropods.

Cryptozoic animals have slowly evolved in harmony with the environment in which they have lived during long periods of time. Man's activity in cutting tracks and roads through their haunts, the bush-fires which accompany man's progress, and the introduction of exotic birds will eventually bring about the extermination of many of these interesting forms of life, and the opportunity of studying them will be gone for ever.

16TH OCTOBER, 1935

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

The following members were elected:—Mr. J. P. Piggott, Mr. S. H. Wellington, Miss Z. G. Ryan.

Reference was made to the loss the Society had sustained in the death of Sir Elliott Lewis. A wreath had been sent by the Council on behalf of the Society, and also a letter of condolence to Lady Lewis and family. His Excellency asked the meeting to confirm the action of the Council, and the motion was passed in silence, the meeting standing as a mark of respect to Sir Elliott Lewis.

Professor A. L. McAulay and Mr. R. G. Brett delivered an illustrated lecture on 'Problems Regarding Tasmanian Eucalypts,' of which the following is an abstract:—

Some of the difficulties of founding the study of Tasmanian eucalypts on recognized botanical species were discussed, and it was suggested that the best starting-point was a search for jordanons. Some jordanons of *E. Gunnii* and related species were given as examples. The cider gum of the Great Lake plateau was mentioned as one, and it was suggested that the trees labelled *E. Gunnii* in National Park constitute a jordanon of *E. Johnstoni*.

Species were next discussed in which there appears to be a continuous series of types, between extremes which have completely different characters. Work was suggested which should give evidence as to whether this condition was due to hybridisation or to variability in the species. *E. Risdoni*, *E. Tasmanica*, and *E. pauciflora* were cited in illustration.

11TH NOVEMBER, 1935

A meeting was held in the Society's Rooms, Mr. W. H. Clemes presiding.

The following members were elected:—Mr. George Fitzpatrick, Major R. G. Smith, Mr. T. Jacobs.

Upon the motion of Dr. Crowther, supported by Mr. E. A. Unwin, the Society's Medal was awarded to Dr. A. N. Lewis—Mr. W. H. Clemes making the presentation.

Dr. Lewis delivered an illustrated lecture entitled 'Our Pulsating World: The Influence of Earth Movements on Human Development.' (See this Volume, p. 1.)

Northern Branch

Annual Report, 1935

The activities of the Northern Branch during 1935 comprised: Annual meeting, followed by public lecture; four ordinary meetings; seven Council meetings; erection and unveiling of memorial pillar in Royal Park.

All meetings were held at the Public Library, Launceston.

20TH MAY, 1935

Annual Meeting

Mr. W. R. Rolph presided. The following officials were elected for 1935:—

President: Mr. A. L. Meston.

Council: The President, Hon. Tasman Shields, Mr. W. R. Rolph, Mr. R. S. Padman, Mr. F. Heyward, Mr. D. V. Allen, Mr. J. E. Heritage, Mr. F. Smithies, Mr. J. R. Forward, and the Secretary.

Secretary: Mr. E. O. G. Scott.

Hon. Auditor: Mr. R. S. Padman.

The statement of accounts, which disclosed a credit balance of £40, was read and adopted.

Public Lecture

The annual meeting was followed at 8 p.m. by a public lecture, 'Tasmania's Scenic Assets,' by Mr. F. Smithies. In the unavoidable absence of the Hon. the Chief Secretary (Mr. T. D'Alton), the Hon. the Minister for Lands and Works (Major T. H. Davies) presided. There was an attendance of about 350.

24TH JUNE, 1935

The President, Mr. A. L. Meston, presided.

Nominations for membership: Miss Zetta Ryan, B.A.; Mr. G. C. McKinlay.

Illustrated lecture: 'Aboriginal Carvings in Tasmania,' by A. L. Meston, M.A.

Discussion: Messrs. D. V. Allen, C. W. Calver, and E. Scott took part in the discussion following the lecture.

15TH JULY, 1935

The President, Mr. A. L. Meston, presided.

Nomination for membership: Mr. E. R. Hudson, B.Sc., B.Ag.

Illustrated lecture: 'Tasmanian Fishes and Fisheries,' by E. O. G. Scott, B.Sc.

Discussion: Messrs. E. R. Hudson, Littler, and A. E. Evershed took part in the discussion following the lecture.

19TH AUGUST, 1935

The President, Mr. A. L. Meston, presided.

Nomination for membership: Mr. S. Wellington, B.Sc.

Illustrated Lecture: 'The Anti-Transportation Movement in Tasmania,' by A. L. Meston, M.A.

Discussion: Messrs. J. R. Palamountain, J. R. Forward, W. D. Weston, S. Wellington, A. E. Evershed, and E. Scott took part in the discussion following the lecture.

30TH SEPTEMBER, 1935

The President, Mr. A. L. Meston, presided.

Nominations for membership: Major R. E. Smith, Mr. J. Jacobs, B.A.

Papers:

(*a*) 'Extinct Tasmanian Pines: Parts 1 and 2,' by H. H. Scott, F.R.S.A.
(*b*) 'Observations on Visits of the Tasmanian Aborigines to the Hunter Islands,' by A. L. Meston, M.A.
(*c*) 'Observations on Fishes of the Family Galaxiidae: Part 1,' by E. O. G. Scott, B.Sc.

Exhibits: On behalf of Mr. L. C. Willes, the Secretary exhibited a nephrite adze found at East Devonport, and believed to be of New Caledonian origin. A polished stone axe from the collection of the Queen Victoria Museum, found at St. Leonards in 1895, and believed to be of New Zealand origin, was also made available for inspection.

Discussion: Dr. Anderson and Messrs. J. Jacobs, King, Isaacs, and C. W. Calver took part in the discussion following the reading of the papers.

Council Meetings

Meetings of the Council were held on 15th April, 29th May, 26th June, 24th July, 21st August, 11th September, and 31st October.

Memorial Pillar

On 18th September, 1935, at 3.30 p.m., in the presence of a large and representative gathering, there was unveiled a memorial pillar, set up in the Royal Park, Launceston, by the Northern Branch to mark the site of the observatory of the late Mr. A. B. Biggs, where the officially accepted determination of the latitude and longitude of Launceston was made, and to commemorate the astronomical work of Mr. Biggs, a former member of this Society, and a frequent contributor to its 'Papers and Proceedings.'

In the unavoidable absence, through indisposition, of the President of the Society, His Excellency Sir Ernest Clark, K.C.B., C.B.E., the President of the Branch, Mr. A. L. Meston, M.A., performed the unveiling ceremony, supported by His Worship the Mayor of Launceston (Alderman E. E. Von Bibra) and by Col. G. E. Harrap, representing the Historical Society of Tasmania.

Mr. F. Heyward, F.R.A.I.A., and Mr. D. S. Jackson presented the plans and specifications, and the pattern for the inscription-tablet, respectively.

Annual Report of the Education Section of the Royal Society, 1936

Seven meetings were held during the year, from April to October, inclusive. The average attendance was 7·1.

At the annual meeting Mr. H. T. Parker was elected President for the ensuing year.

The papers presented and the discussions arranged during the year were:—

May 27: Mr. H. T. Parker, "The New Spelling Book."

June 24: Mr. F. Watts, "An Experiment in the Education of Gifted Children."

July 22: A Round-Table Discussion was opened by Mr. A. A. Vollprecht on "Scoring the Scholarship Examination."

August 19 and September 23: A Round-Table Discussion was opened by Mr. H. T. Parker on "Broadcasting in the Schools."

October 28: Mr. C. McShane, "An Intelligence Survey in Tasmanian Schools."

Walter E. Shimmins, Government Printer, Tasmania.

PAPERS & PROCEEDINGS

OF

THE ROYAL SOCIETY OF TASMANIA

FOR THE YEAR

1936

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Joseph Pearson, D.Sc. (Manc.), D.Sc. (Liverpool), F.R.S.E., F.L.S.

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Papers and Proceedings, 1936

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PAP. & PROC. ROY. SOC. TASMANIA, 1936 (~~31st May~~, 1937)

The Embryology of the Syncarid Crustacean, Anaspides tasmaniae

By

V. V. HICKMAN, B.A., B.SC., C.M.Z.S.
Ralston Lecturer in Biology, The University of Tasmania

PLATES I-XIII

(Read 9th November, 1936)

INTRODUCTION

Within recent years our knowledge of crustacean embryology has been augmented by the work of Prof. H. G. Cannon on the Branchiopoda, and that of Dr. S. M. Manton on the Leptostraca and Mysidacea. Nothing, however, has been published on the embryology of the Syncarida.* An examination of the development of *Anaspides tasmaniae* Thomson was therefore undertaken. The investigation was carried out at the University of Tasmania during the years 1932-36. The following pages contain an account of the work accomplished up to the end of that period. It is hoped eventually to supplement this research by a further examination of the post-embryonic development.

I desire to express my thanks to the trustees of the John Ralston Bequest, under whose auspices the investigation was made; to Dr. S. M. Manton for copies of her publications; and to my former teacher, Prof. T. T. Flynn, for helpful advice and kindly interest in my work.

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* As mentioned above, no previous work on the embryology of a Syncarid crustacean has been published. However, G. Smith (1909, p. 549) has given a brief description of the egg of *Anaspides tasmaniae*, and has stated that he was 'convinced that no complicated metamorphosis is passed through' during development, but that it was 'possible, however, that the young are hatched out from the egg, not with the complete adult structure.'
Sayce (1907, p. 117) has described an immature form of *Koonunga cursor*, which differs but slightly from the adult, and Chappuis (1927, p. 602) states that there appears to be no metamorphosis in the development of the Bathynellidae.

Method of Obtaining the Eggs

The eggs of *Anaspides* measure about 1·0 mm. in diameter. They are laid singly, attached to pieces of wood or other débris in the streams and tarns where the shrimp occurs. Sediment and algal growths in the water soon cover the eggs, concealing them from view, and making it almost impossible to find them.

In March, 1932, a small laboratory aquarium was built and stocked with specimens of *Anaspides*. Little success, however, attended the experiment. It was soon realized that the conditions prevailing in the mountain streams could not be reproduced satisfactorily in the laboratory. Adult specimens of the shrimp rarely lived longer than six to eight weeks under artificial conditions, and no eggs were found in the aquarium. Half-grown specimens could be kept alive for a much longer period, but they died before reaching maturity.

In November, 1932, it was decided to keep a number of shrimps under more natural conditions in a stream on the slopes of Mount Wellington. For this purpose a tributary of the New Town Creek was selected. This stream flows down the north-eastern slopes of the mountain, and empties into the River Derwent at New Town Bay. The bed of the stream is composed of large basaltic rocks and boulders intermingled with coarse gravel and sand. Apart from algal slime there is very little aquatic vegetation in the creek.

During bright, sunny days the adult shrimps spend most of the time hiding in dark recesses among the rocks where the water is flowing rapidly, and it is in such places that they usually lay their eggs. In order to obtain the eggs two small wooden boxes, each measuring about 25 x 20 x 15 cm., were prepared. Through the ends of each box eight holes (15 mm. in diameter) were bored. These were covered on the inside with wire gauze to allow water to circulate freely through the boxes. Two or three stones, some vegetable débris from the bed of the creek, and some pieces of fibrous bark were placed in each box. Fifteen to twenty adult specimens of *Anaspides* were then introduced and the lid closed. The boxes were next completely submerged in a swiftly flowing part of the stream, a number of heavy stones being placed on top of them to keep them from being washed away.

The two boxes were prepared and stocked with shrimps in the above manner on the 9th November, 1932. The creek was not visited again until the 23rd January, 1933. The boxes had therefore been undisturbed for about ten weeks, but the specimens of *Anaspides* were still alive, and appeared to be quite healthy. The water circulating freely through the boxes had carried sufficient food for the shrimps, which had not only survived the ten weeks' confinement in almost complete darkness, but had also laid a number of eggs. Seven eggs were found in one box and thirty-five in the other. Most of the eggs had been deposited in cracks and crevices in the wood of the boxes, some were on pieces of bark, but only a single egg was found attached to a stone. It was very difficult to remove the eggs without damaging them, since they adhered firmly to the surface on which they had been laid. The pieces of bark, with eggs attached, were therefore placed in water and taken to the laboratory for examination.

The boxes were restocked with *Anaspides* on the 23rd February, and examined periodically. It soon became evident, however, that two boxes were not sufficient. The necessity of leaving the boxes undisturbed over long periods in order to obtain eggs at advanced stages of development made it imperative to place a larger number of boxes in the stream. This procedure was also hastened by the fact that heavy rain fell on the 4th and 5th October, 1933; the creek was flooded and my two boxes washed away. On 10th October the floodwater had subsided sufficiently to allow a new box to be stocked and placed in the stream. Other boxes were added at intervals, and by 10th January, 1934, eleven boxes had been stocked with shrimps and placed in the stream at slightly different altitudes on the mountain. A record of the date, when each box was stocked with shrimps and when eggs were found in it, was kept.

If small strips of wood about the size of a microscope slide were lightly tacked on to the lid of the box, leaving a space of about 1·2 mm. between the wooden strip and the lid, the shrimps would often lay their eggs in this space. The eggs adhered to the wooden strip, which could then be removed with the eggs attached. Moss, rootlets, bark, and stones were also used as natural substances on which the shrimps might deposit their eggs. Of these materials fibrous bark proved to be the most satisfactory. Eggs were rarely laid on stones. (Fig. 1, Pl. I.)

Laying Period

In order to eliminate as far as possible any effect which long confinement might have on the laying period of *Anaspides*, some of the boxes were stocked with new shrimps each month, and the eggs were searched for shortly after the introduction of the shrimps. A fortnight usually elapsed before the shrimps became accustomed to the box and commenced to lay their eggs. Each month of the year eggs at the two-celled and four-celled stages of development were found in the boxes. Laying is therefore not restricted to any particular season, but goes on throughout the year. It appears, however, to be most active during October and November.

Time and Rate of Development

No difficulty was experienced in the laboratory in hatching embryos, which had been allowed to complete their gastrulation stage before being removed from the creek. Some were kept in running water; others were placed in water in petri dishes, and the water frequently changed. Except for short intervals, when the eggs were being examined under the binocular microscope, they were kept in the dark. Some eggs were left to develop under natural conditions in the mountain stream, so that their time of development might be compared with that of eggs kept under laboratory conditions.

Owing to several of my boxes being washed away on four different occasions by floods in the creek, I am not able to give an unbroken series of results for any one particular year. However, observations carried out over a period of three years have made it possible to determine with reasonable accuracy both the time and the rate of development of the egg of *Anaspides.*

Some of the eggs found in the boxes on the 23rd January, 1933, had already reached the egg-nauplius stage. They were kept under observation in the laboratory until the 21st July, 1933, when one of the embryos hatched out. Eggs laid during the spring and summer months, October to March, take from eight to nine weeks to reach the egg-nauplius stage. Hence the total time of development in the case of the abovementioned embryo was about 35 weeks. Five eggs laid in one of the boxes on or about 28th November, 1933, were allowed to remain in the creek until 16th April, 1934. They were then removed to the laboratory. The embryos hatched out of three of the eggs during the second week of July, 1934, and out of the other two eggs in the following week, the total time of development being 32 to 33 weeks.

The time taken by the embryo to reach different stages in its development may be determined from the results shown in Table I. The transparent nature of the chorion and larval membranes makes it possible to recognize many of the stages of development without having recourse to dissection.

TABLE I.

Rate of Development of the Embryo of *Anaspides* in Eggs Laid during the Months October to March.

Approx. Date of Laying.	*Date of Examining.*	*Age of Embryo in Days.*	*Stage of Development.*	*Remarks.*
16 Nov., '32	23 Jan., '33	68	Early nauplius	fig. 23, Pl. III
16 Nov., '32	4 Mar., '33	108	Post nauplius	fig. 29, Pl. IV
16 Nov., '32	21 July., '33	247	Hatching	
31 Oct., '33	22 Dec., '33	52	Gastrulation	fig. 20, Pl. III
31 Oct., '33	4 Jan., '34	65	Early nauplius	fig. 23, Pl. III
16 Nov., '33	7 Feb., '34	83	Late nauplius	fig. 28, Pl. IV
21 Nov., '33	16 April, '34	146	Thoracic appendages	
28 Nov., '33	12 July, '34	226	Hatching	
5 Mar., '34	2 May, '34	58	Germinal disc	fig. 21, Pl. III
8 Mar., '34	2 June, '34	86	Late nauplius	fig. 28, Pl. IV
16 Jan., '35	18 Feb., '35	33	Beginning of gastrulation	fig. 17, Pl. III
28 Feb., '35	27 Mar., '35	27	Stage just previous to gastrulation	fig. 16, Pl. II.

Eggs laid during the autumn and winter months, April to September, develop to the gastrulation stage, and then remain dormant until the end of October, when development continues, and the embryos hatch out in the following June. An egg laid in April will therefore take about 60 weeks to hatch. The rate of development of eggs laid in the months April to September is indicated in Table II. The results given in this table and in Table I. are selected from observations made on eighty different eggs during the last three years.

TABLE II.

Rate of Development of the Embryo of *Anaspides* in Eggs Laid during the Months April to September.

Approx. Date of Laying.	*Date of Examining.*	*Age of Embryo in Days.*	*Stage of Development.*	*Remarks.*
1 April, '33	4 April, '33	3	Two cells	fig. 7, Pl. II
1 April, '33	8 April, '33	7	Thirty-two cells	
20 April, '33	17 Oct., '33	180	Gastrulation	fig. 18, Pl. III
31 May, '34	21 July, '34	51	Gastrulation	fig. 18, Pl. III
31 May, '34	8 Dec., '34	191	Post nauplius	fig. 29, Pl. IV
30 June, '34	4 July, '34	4	Eight cells	fig. 11, Pl. II
11 July, '34	8 Sept., '34	59	Gastrulation	fig. 18, Pl. III
11 July, '34	10 Oct., '34	91	Gastrulation	fig. 18, Pl. III
11 July, '34	20 Nov., '34	132	Late nauplius	fig. 28, Pl. IV
28 Aug., '34	12 Sept., '34	15	About 128 cells	
19 Sept., '34	20 Nov., '34	62	Gastrulation	fig. 18, Pl. III

The Hatching Period

It has already been mentioned that eggs laid in the creek during November, and kept for some time under laboratory conditions, hatched in the following July. In order to determine the limits of the hatching period under natural conditions a large number of shrimps were collected from the creek each month from March, 1934, to February, 1935. The length of each specimen from the anterior end of the rostrum to the posterior end of the telson was measured in millimetres. In the case of the small specimens in which the rostrum had not yet been formed, the length was taken from the front of the head to the end of the telson. The percentage number of shrimps of each size from 3·0 mm. to 20·0 mm., found in the catch for each month, was then determined. The results are shown in Table III.

The absence of small specimens of 3-4 mm. in length from the catches for the months November to May, and the presence of such specimens in the catches for the months June to October, make it quite clear that hatching takes place during the latter period. The results also indicate that most of the eggs hatch at the end of June or the beginning of July.

TABLE III.

Percentage Number of Specimens of *Anaspides* of Different Sizes taken in the New Town Creek each month from March, 1934, to February, 1935.

Length of Shrimps in mm.	*Percentage Number Taken on—*											
	7th Mar., 1934.	*16th Apr., 1934.*	*24th May, 1934.*	*16th June, 1934.*	*21st July, 1934.*	*21st Aug., 1934.*	*12th Sept., 1934.*	*19th Oct., 1934.*	*20th Nov., 1934.*	*20th Dec., 1934.*	*21st Jan., 1935.*	*18th Feb., 1935.*
3·0	....	....	...	3	12	2	1	...	...	....	....	...
4·0	....	..	...	....	40	3	37	15	...	....	....	....
5·0	...	...	....	....	12	17	6	18	8	1	...	....
6·0	....	....	....	....	2	17	7	16	14	1	1	....
7·0	...	...	...	....	....	6	...	7	28	14	1	....
8·0	9	....	....	....	...	...	..	2	8	23	8	1
9·0	31	6	..	2	...	....	1	6	3	24	14	8
10·0	19	6	12	4	6	..	1	2	3	6	18	11
11·0	15	38	4	7	4	6	4	....	...	6	14	18
12·0	16	21	14	15	6	2	1	...	...	2	9	23
13·0	4	4	23	13	.	5	7	....	..	..	3	16
14·0	1	10	6	17	4	20	8	....	....	...	2	5
15·0	..	4	17	9	2	12	5	...	...	..	1	3
16·0	1	2	12	7	..	5	8	3	4	1	.	....
17·0	...	...	2	3	2	2	3	7	11	....	..	....
18·0	1	2	....	3	...	...	..	15	3	1	2	....
19·0	..	..	...	..	2	....	..	6	4	2	2	....
20·0	....	..	....	2	....	..	7	..	2	11	2	....
Others	3	7	10	15	8	3	4	3	12	8	23	15

Technique, Fixation, and Staining

In eggs not covered with débris the chorion is so transparent that the embryo may be observed in the living state and certain phases of its development followed.

The fixation of the egg is most difficult. The chorion is not penetrated by Smith's formol-bichromate fluid, which Prof. Cannon (1921, p. 629) and Dr. Manton (1928, p. 364) used in their researches on crustacean embryology. Gilson's fluid and cold sublimate-acetic also fail to penetrate. Hot sublimate-acetic is far too drastic, and disorganizes the yolk. Bouin's picroformol penetrates the chorion very slowly, and will fix early stages. However, as soon as the vitelline membrane has been formed, Bouin's solution fails to give satisfactory results. The tendency of the chorion to curl inwards when broken, and the semi-fluid nature of the yolk, render removal of the chorion, without injury to the embryo, almost impossible. As development proceeds other membranes or larval integuments are formed, and these add to the difficulty of fixation.

The only fixative found to penetrate the chorion, vitelline membrane, and larval integuments is Carnoy's fluid (Glacial acetic acid 1 part, Absolute alcohol 6 parts, Chloroform 3 parts). This fluid penetrates with considerable rapidity, and tends to cause invagination of the chorion, accompanied by distortion of the embryo. This may be avoided, however, by making a very small perforation in the chorion. Fixation is complete in from 40 to 50 seconds. The eggs are then transferred to 90 per cent. alcohol for 24 hours. The yolk is thus hardened sufficiently to allow removal of the chorion without injury to the embryo. It is not necessary to remove the vitelline membrane, but the thick chorion is an obstacle to accurate orientation. Moreover, it becomes hard and brittle during the process of infiltration, causing trouble later in section cutting. Its removal may be carried out under a binocular dissecting microscope with the aid of needles.

In the one-celled stage the zygote occupies the whole space enclosed by the chorion, and adheres to the latter on fixation. Sections of this stage, therefore, had to be cut with the chorion *in situ*. Many failures resulted, but several complete series of sections of the one-celled stage were thus obtained. In later stages this difficulty is not encountered, and the chorion may be removed in the manner described above.

To facilitate manipulation and orientation, the eggs were stuck on to small pieces of hardened sheep's brain by the celloidin method. They were then infiltrated with paraffin wax (M.P. 56° C.). Forty minutes in the wax bath gave satisfactory infiltration without rendering the yolk brittle. The wax was changed once before the definitive embedding.

Serial sections were cut at thicknesses of 8-12 μ , and stained with Ehrlich's acid haematoxylin, eosin being sometimes used as a counterstain.

In addition to serial sections, whole mounts of the young germinal disks were made. These were prepared in the following way: After fixation the embryo was stained for about 40 hours in alum-carmine, and then differentiated in acid alcohol for about the same length of time. It was then embedded in paraffin, placed on the microtome, and all the part, other than the germinal disk, cut away. The disk was then removed from the paraffin block by the aid of xylol, and mounted.

GENERAL EMBRYONIC DEVELOPMENT

The Unsegmented Egg

The newly laid egg of *Anaspides* has a faint purple tinge, and is surrounded by a thick transparent chorion. It is almost spherical in shape, and, including the chorion, measures about one millimetre in diameter. Ten eggs, when measured under a micrometer eyepiece, gave the following results in millimetres:

(*a*)	1·03 x 1·07
(*b*)	1·01 x 1·05
(*c*)	1·03 x 1·03
(*d*)	1·05 x 1·07
(*e*)	0·98 x 1·04
(*f*)	0·97 x 1·05
(*g*)	0·98 x 1·03
(*h*)	0·96 x 1·08
(*i*)	1·03 x 1·08
(*j*)	0·92 x 1·08

The chorion measures about 14 μ in thickness, and is composed of two layers firmly united. The outer layer is 12 μ in thickness, and in transverse section is seen to be perforated by numerous minute radial tubules. The inner layer measures 2 μ in thickness, and is homogeneous. The outer surface of the chorion is slightly rough, and in the newly-laid egg it is sticky. Sand grains, algal filaments, and other débris in the water of the creek adhere to the egg, and soon hide it from view. The inner surface of the chorion is smooth and has a glazed appearance. When the egg is laid the chorion is quite colourless, but after a few days it takes on a brownish tinge, which is probably due to the absorption of tannins or other pigments derived from fallen leaves and other vegetable matter in the water.

In consistency the chorion resembles a layer of chitin of the same thickness, but it is more readily broken. When fractured it tends to curl inwards and crush the egg. This tendency is retained to some degree even in specimens which have been embedded in paraffin and sectioned.

The newly-laid egg fills the whole space enclosed by the chorion, and at this stage no vitelline membrane is present. The yolk granules are almost spherical in shape, and vary from 5 μ to 19 μ in diameter. The larger granules appear to be more numerous near the surface than near the centre of the egg.

The earliest cytological condition found among the unsegmented eggs examined shows the sperm-nucleus and the egg-nucleus approaching each other. Each nucleus is surrounded by an irregular mass of protoplasm, from which long protoplasmic filaments radiate out amongst the yolk granules. The sperm-nucleus has an irregular ovoid shape, and measures 42 x 48 μ. It is situated about half-way between the centre and outer surface of the egg. The egg-nucleus is also of an irregular ovoid shape, and measures 51 x 57 μ. It is near the centre of the egg.

The next stage shows the two nuclei in contact. The nuclear membranes, however, are still intact, and fusion has not yet taken place. (Figs. 3 and 4, Pl. I.) This stage was met with in a number of eggs, and it is probable that the two germ-nuclei remain in contact for some time before actual fusion occurs. Eventually, however, the intervening nuclear membranes break down, and the two nuclei coalesce to form a zygote nucleus at the centre of the egg.

While these changes are in progress a marked decrease in the volume of the egg occurs. An egg which, excluding the chorion, measures 1·02 x 1·04 mm. when newly laid, may decrease in size to such a degree, that it measures only 0·65 x 0·71 mm. when the zygote nucleus is formed. As the volume of the egg decreases, the yolk granules, which are somewhat widely separated in the cytoplasm of the newly-laid egg, are brought closer together. The contraction also results in the formation of a wide space between the egg and the chorion.

Segmentation

The egg of *Anaspides* undergoes total segmentation, and, up to the eight-celled stage, the blastomeres are equal in size. The first cleavage furrow is meridional, and divides the egg into two cells, which, at first, are so loosely held together, that they readily fall apart (figs. 5 and 6, Pl. I). However, before the next division, the two cells appear partly to fuse again, and the cleavage furrow becomes shallow (figs. 7 and 8, Pl. II). Serial sections through embryos at the two-celled stage show the nucleus of each blastomere to be near the centre of its cell, and surrounded by an irregular mass of protoplasm, from which strands radiate out among the yolk-granules.

The second cleavage takes place in the usual manner, being meridional and at right angles to the first furrow (figs. 9 and 10, Pl. II). The third cleavage is equatorial, giving rise to eight cells. At first the four blastomeres at one pole are superposed on those at the other pole, but the cells soon move into a position in which the four blastomeres at one pole alternate with those at the other (fig. 11, Pl. II). These eight cells show no tendency to fuse, and after fixation they may be easily separated from one another. Yolk is distributed uniformly through the eight cells.

When segmentation commences, or shortly afterwards, a delicate vitelline membrane is formed around the embryo. At first this membrane is very thin, and fixatives penetrate it, but, when the eight-celled stage has been reached, the membrane is so thick, that it presents a serious obstacle to proper fixation.

The rate of cleavage is slow. An embryo examined at 8.30 p.m. on 4th April was at the two-celled stage. Twenty-four hours later it had reached the four-celled condition, and at 9 p.m. on the 8th April thirty-two blastomeres had been formed.

At the sixteen-celled stage (fig. 12, Pl. II) a small blastocoel has been formed in the centre of the embryo (fig. 13, Pl. II). As segmentation continues the size of the blastocoel becomes larger.

Mesoderm Formation

Segmentation has now become irregular, and appears to be more active at one than at the other pole of the embryo. When moved about, the living embryo usually rotates within the vitelline membrane so that the same pole is always uppermost. It is at this pole that segmentation appears to be more active and the cells smaller than at the other pole. Between the sixteen-celled stage and the thirty-two celled stage a blastomere at the uppermost pole slips into the blastocoel (figs. 13 and 14, Pl. II). As segmentation proceeds, further cells from this pole enter the segmentation cavity, with the result that the surface of the embryo at this pole presents a pitted appearance.

The embryo has now assumed the form of a blastula, the wall of which is composed of a single layer of wedge-shaped blastomeres, surrounding a cavity which is partly filled by an inner mass of cells not arranged in any definite manner (figs. 15 and 16, Pl. II). This inner cell-mass constitutes the primary mesoderm.

The total number of cells entering the blastocoel could not be determined. Serial sections showed that some cells, which had already entered the segmentation cavity, were undergoing mitosis, while others were passing inward.

As development proceeds the nuclei of the outer blastomeres gradually approach the surface. All the cells of the embryo are uniformly rich in yolk.

Gastrulation and Endoderm Formation

When the inward migration of cells into the blastocoel to form the primary mesoderm has ceased, the outer surface of the embryo presents a uniformly segmented appearance. There is very little difference between the blastomeres of the two poles. The pitted appearance of the surface is no longer visible.

The process of gastrulation is initiated by the formation of a crescent-shaped depression occupying a large area at the uppermost pole (figs. 17 and 19, Pl. III). The invagination gradually deepens, its opening becoming smaller and somewhat triangular (fig. 18, Pl. III). This opening is the blastopore. The invagination becomes so deep that it reaches the mass of mesoderm cells in the blastocoel (fig. 20, Pl. III). It constitutes the endodermal rudiment, and later gives rise to the yolk-sac, mid-gut, and liver lobes. The mesoderm cells are pushed to one side of the blastocoel by the invagination and become somewhat flattened. They eventually spread out under the ectoderm and below the future position of the germinal disk.

Invagination goes as far as possible, and at one stage there is a deep archenteric cavity (fig. 20, Pl. III). It is, however, not a permanent cavity, for cells continue to move inward, crowd together, and obliterate its lumen. The blastopore grows smaller as gastrulation advances, and it finally closes when the cells around its margin come together. However, it never disappears entirely, its position being marked by a small depression in the surface of the embryo. This depression is later replaced by the opening of the proctodaeum.

The endoderm now forms a solid core of cells, which, together with the mesoderm, fills the whole of the blastocoel. All the cells of the embryo are laden with yolk-granules, and, apart from their position, there is little to distinguish the mesoderm cells from those of the endoderm.

In eggs laid in the spring and summer the close of gastrulation is marked by a short period of rest. In autumn and winter eggs it is followed by a long period of dormancy.

Formation of Germinal Disk and Egg-nauplius

After the quiescent period following gastrulation, cell division takes place actively over a wide area immediately in front of the blastopore. This active cell division gives rise to the germinal disk. Its narrow posterior end terminates at the blastopore, whilst its broader anterior end and its sides merge into the region surrounding them. In eggs laid during spring and summer the embryo takes about 60 days to reach the stage of development in which the germinal disk is fully differentiated.

The disk now becomes thickened laterally, while the cells composing its antero-median portion become thin. In this way the typical V-shaped form of the disk, seen in so many crustacean embryos, is attained (fig. 21, Pl. III).

This stage is soon followed by the appearance of the egg-nauplius. The first sign of its development is the formation of the stomodaeum. This appears as a deep crescent-shaped invagination between the arms of the V, and slightly in front of the middle of the disk. The invagination extends backwards below the disk towards the blastopore. At this stage the posterior margin of the stomodaeum is much higher than its anterior margin. The rudiments of the naupliar appendages appear simultaneously as three pairs of thickenings on the lateral arms of the disk. These thickenings soon stand out in high relief above the surface of the disk. The opening of the stomodaeum is now seen to lie between the rudiments of the antennae (fig. 23, Pl. III). Immediately in front of the blastopore is a pair of small lateral thickenings, which later give rise to the caudal papilla. The portion of the disk in front of the stomodaeum and between the antennules soon becomes thickened and elevated to form the labrum.

Up to this stage there has been very little indication of the development of the head-lobes, but now, on each side immediately in front of the bases of the antennules, active cell-proliferation occurs, and the paired rudiments of the head-lobes are established. The labrum is gradually raised above the surface of the disk, and commences to project over the opening of the stomodaeum. The paired lateral elevations in front of the blastopore come together, forming the lobes of the caudal papilla. The extremities of the antennae and mandibles are now distinctly bilobed (fig. 24, Pl. III).

While these changes have been taking place, a marked contraction in the area of the germinal disk has occurred. When the rudiments of the naupliar appendages first appeared, they were widely removed from the median line, and projected beyond the sides of the embryo. Now they have been drawn towards the median line, and also closer together (fig. 27, Pl. IV).

Ectodermal Teloblasts

Soon after the establishment of the rudiments of the naupliar appendages the ectodermal teloblasts appear. These at first form an irregular transverse row on either side of the mid-ventral line and immediately in front of the blastopore. Each row consists of seven cells (fig. 25, Pl. IV). The inner ends of the two rows are united by a teloblast in the mid-ventral line. As the germinal disc contracts and the bases of the naupliar appendages are brought closer together, the teloblasts tend to form a curved row round the caudal papilla, which has now been formed (fig. 26, Pl. IV). Yolk-granules in the teloblastic cells are rapidly absorbed, and the cell-nuclei become greatly enlarged. This is soon followed by the division of the cells to form the usual tranverse rows of descendants. The teloblasts do not form a complete ring around the caudal papilla until about the fourteenth week. The complete ring consists of nineteen cells, there being one in the mid-ventral line and nine on each side (figs. 53-54, Pl. VIII).

During the development of the egg-nauplius a new investing membrane is formed. This is the *first larval integument* or *embryonic cuticle*. It eventually becomes very thick and elastic, and plays an important part in the process of hatching.

The embryo is now surrounded by three investments, namely, the chorion, the vitelline membrane, and the first larval integument.

Whenever the age of an embryo is mentioned in the following pages, it is to be regarded as having reference to an embryo developed in an egg laid in early summer.

Further Changes in the External Shape of the Embryo

In eggs laid during early summer the embryo takes about eleven weeks to reach the stage of development shown in fig. 27, Pl. IV. In the twelfth week the head-lobes develop rapidly and the labrum increases in length and breadth. Little change occurs in the shape of the antennules, but the bilobed nature of the antennae becomes still more pronounced, the exopodite being distinctly longer than the endopodite. The mandibles lose their bilobed appearance and become pyriform, the narrow distal portion later giving rise to the mandibular palp. Meanwhile the caudal papilla has increased in size, and the opening of the proctodaeum has become established in the position formerly occupied by the blastopore. The first row of ectodermal teloblasts partly encircling the papilla appears at this stage (fig. 28, Pl. IV).

In fourteen weeks the head lobes are clearly defined, and curve outward in front of the base of the antennules. The central cell of each lobe is still visible. A rudimentary median eye in the form of a small pigment-spot has appeared in the apex of the V-shaped area between the head-lobes (fig. 29, Pl. IV). The tip of the labrum lies between the mandibles. The three basal segments of the antennules are established. In the antennae the two basal segments, coxopodite and basipodite, are first differentiated at this stage, and there is a marked increase in the length of the two rami, but the exopodite is still somewhat longer than the endopodite. The embryo has now become distinctly narrower and more elongate, but is wider anteriorly than posteriorly. Immediately behind and between the mandibles appear the rudiments of the maxillules. These are separated from the caudal papilla by the tranverse caudal furrow. This furrow and the maxillules are soon hidden by the bending forward of the papilla. The end of the papilla is divided into two blunt lobes, which subsequently give rise to the caudal fork. The proctodaeum opens in the notch between the caudal lobes.

The post-mandibular segments of the trunk are formed by growth from teloblasts in front of the blastopore, and arise in succession from before backwards. The limb rudiments also appear in succession from before backwards.

The first larval integument has now become relatively thick. It surrounds the embryo loosely, and is attached only at the ends of the antennules and antennae. A *second larval integument* has been formed, but is not shed until just before hatching.

In about sixteen weeks the central cell of the head-lobes has disappeared. The median eye-spot has become larger and more distinct. The antennules and antennae have commenced to curve upwards and backwards at the sides of the embryo. The two rami of the antennae are segmented, and the endopodite, which at first was shorter than the exopodite, is now equal to it in length. The rudiments of the maxillules are now followed by those of the maxillae and the first three pairs of thoracic appendages. The caudal papilla has curved forward, and the angle of flexure has shifted to the third thoracic segment (fig. 30, Pl. IV).

In eighteen weeks pigmentation of the paired eyes appears. The median eye-spot has become elongated and pear-shaped. The endopodite of the antennules is not yet formed. The antennary endopodite is now distinctly longer than the exopodite, and as development proceeds the difference in length becomes more pronounced owing to retardation in the growth of the exopodite. The rudiments of the first seven pairs of thoracic appendages have been formed, and the biramous nature of the first six pairs soon becomes apparent. At first there is very little difference in length between endopodite and exopodite. Eventually, however, the growth of the endopodite exceeds that of the exopodite. The embryo has now completed a little more than half the period which it spends in the egg. Flexure of the body and the increase in length of the embryo have brought the caudal extremity into contact with the front of the labrum. The body tapers gradually from the anterior to the posterior end, there being no sudden diminution in size at any point.

From this stage onward the chief changes in form consist in the further development of the appendages. The eighth thoracic limbs soon appear, and are followed in succession by the abdominal limbs. The epipodial gills of the first seven thoracic appendages are developed shortly before hatching. The small leaf-like endopodite, which, in the adult, is present on the first four pairs of abdominal limbs, is not developed until after hatching. As they develop the thoracic limbs are directed downwards, the second, third, and fourth pairs being on the outer side of the others, which, owing to the flexure of the body, lie between them. The five pairs of abdominal appendages and the uropods at first curve upwards at the sides of the abdomen.

At the twenty-second week a large saddle-shaped median dorsal-organ has been formed. Anteriorly it is bounded by a transverse groove immediately behind the paired eyes, whilst its posterior margin is the junction between the first and second thoracic segments. Laterally it extends to the level of the paired eyes. In the living embryo the organ has a yellowish appearance. It seems to reach its maximum development about the twenty-fifth week, and then slowly degenerates, but does not disappear until after hatching. No dorso-lateral organs are present.

During the last few weeks before hatching the embryo becomes deeply pigmented on the front of the head between the eyes, and to a less extent on the back and sides of the trunk segments (fig. 31, Pl. V).

As stated above, the embryo hatches from eggs laid during early summer in from thirty-two to thirty-five weeks.

POST-EMBRYONIC DEVELOPMENT

The Process of Hatching

As mentioned previously, five eggs hatched in the laboratory during the second and third weeks of July, 1934. In the case of one of these eggs I was fortunate enough to observe the process of hatching. Shortly before 12 midnight on the 17th July a crack appeared in the chorion, and extended gradually round it in a meridional plane (fig. 32, Pl. V). At 12.10 a.m. on the 18th July the crack had opened and the vitelline membrane had burst. The first larval integument, however, was still intact, but had commenced to bulge out through the opening in the chorion. It was becoming slowly distended by osmosis. The expanding of this membrane gradually forced apart the two portions of the chorion, thus preventing their curling inwards and crushing the embryo (fig. 33, Pl. V). The shrimp was now enclosed in a perfectly transparent ovoid sac formed by the first larval integument. This sac measured 2·0 x 1·8 mm. It still had the two portions of the chorion and fragments of the ruptured vitelline membrane attached to its outer surface. The increased space within allowed the shrimp to unflex its body, which up to the present had been strongly curved, with the ventral surface of the telson resting against the front of the head (fig. 34, Pl. V). The ovoid sac eventually became quite free from the chorion, and assumed a spherical form. At 1 a.m. it had expanded to a diameter of 2·5 mm.

The shrimp was now moving about actively, and endeavouring to throw off the second larval integument. This had already split on the dorsal side, and was being slowly pushed off the appendages. Ultimately the ecdysis was completed, and the second larval integument lay in a crumpled mass inside the balloon-like first larval integument. At 1.10 a.m. the latter burst, allowing the shrimp to escape.

In another specimen, in which the chorion cracked before 7.30 p.m. on 12th July, the first larval integument did not burst and liberate the shrimp until about 9 p.m. on 13th July.

From the above observations the first larval integument, which is very strong and elastic, seems to serve two important purposes. In the first place, it absorbs water by osmosis, expands, and forces apart the two portions of the fractured chorion. In the second place, it provides a roomy chamber where ecdysis of the second larval integument may take place in safety. (See also fig. 2, Pl. I).

External Characters of the Hatched Embryo

The newly-hatched shrimp (fig. 35, Pl. V) measures 2·70 mm. in length. It differs from the adult mainly in having sessile eyes, no rostrum, a notched telson, and no endopodites on any of the appendages of the first five abdominal segments.

The antennules measure about 1·2 mm. long. The peduncle consists of the three segments present in the adult. The inner flagellum has three, and the outer eleven, segments. Setae are distributed as shown in fig, 36, Pl. VI. The statocyst in the basal joint of the peduncle is well developed, and already contains five clavate rods.

The antennae are slightly shorter than the antennules. The protopodite consists of the usual two segments. The endopodite has nine segments, while the exopodite, which, during embryonic life, was relatively large, has now degenerated to a small scale (fig. 37, Pl. VI).

The head is rounded in front, and has a median longitudinal groove, which extends backward to meet a transverse groove close behind the paired eyes (fig. 40, Pl. VI). This transverse groove grows forward as a V-shaped structure, which subsequently gives rise to the rostrum (fig. 41, Pl. VI), and is therefore called the rostral groove. Immediately behind this groove is a second transverse furrow, which becomes the cervical groove of the adult. The gradual infolding of the ectoderm on each side of the rostral rudiment gives rise to the pedunculated condition later attained by the paired eyes (figs. 42 and 43, Pl. VI). The infolding takes place slowly, and movable articulation of the eyes is not established until eight weeks after hatching. The shrimp is then 4·6 mm. long, and, since escaping from the egg, has undergone at least two ecdyses.

A specimen which hatched in the laboratory on 18th July, 1934, and measured 2·70 mm. long, underwent an ecdysis on the 10th August, 1934, and then measured 3·25 mm. long. Its eyes were still sessile. The specimen was kept alive until 20th August, 1934, when it died, its length being 3·60 mm. All specimens under 4·6 mm. long collected from the mountain streams have sessile eyes.

The rudimentary median eye is still present, situated in front of the head, between and slightly above the basal joints of the antennules. It soon degenerates, and has almost disappeared in specimens 4·0 mm. long.

The four-celled sense-organ on the dorsal surface in front of the cervical groove does not appear until the animal is nearly 5·0 mm. long.

The number of trunk-somites is the same as in the adult, and on the dorsal side there is no indication of the anterior limit of the first thoracic somite. The distance of the cervical groove from the front edge of the second thoracic somite is relatively much greater than in the mature animal. The lateral extensions of the groove run vertically, instead of obliquely, down each side, and end just behind the mandibles. The horizontal groove running backward from the cervical groove on each side is present, but not very pronounced. There is little indication that the sixth abdominal segment is made up of two fused somites.

The telson (fig. 44, Pl. VII) is divided by a deep notch into two lobes, each of which ends in a fringe of six short setae. As the animal grows the notch becomes smaller, and disappears when the shrimp is about 5·3 mm. long.

The mandibles (fig. 39, Pl. VI), maxillules (fig. 47, Pl. VII), and maxillae (fig. 46, Pl. VII) differ very little from those of the adult. The thoracic limbs are also like those of the mature animal (fig. 38, Pl. VI). The first five pairs of abdominal appendages, however, consist only of the protopodite with a six-jointed exopodite (fig. 45, Pl. VII). The small flabellate endopodite of the first four abdominal limbs does not appear until the animal is 7·0 mm. long. The uropods have the same form as in the adult.

External differences between the sexes do not become apparent until about twenty weeks after hatching. Indications of the development of the copulatory styles in the male are first visible in specimens 10·0 mm. long. In such specimens the endopodites of the first two pairs of abdominal limbs are distinctly elongated and narrow. The serrated spines on the basal part of the inner flagellum of the antennules in the male are not evident until the shrimp is 16·0 mm. long. The first spine to be developed is a long prolateral spine on the sixth segment of the flagellum.

In the female the first external sexual character to appear is the conical papilla situated between the last pair of thoracic limbs. This papilla makes its earliest appearance in specimens about 12 mm. long, but the opening of the spermatheca upon it is not developed until a later stage.

DEVELOPMENT OF ORGANS

Further Development of the Mesoderm

When differentiation of the germ-band is completed the mesodermal cells underly it. These cells now constitute the naupliar mesoderm, and are arranged in longitudinal strands below the rudiments of the naupliar appendages (fig. 49, Pl. VII). The posterior ends of the strands lie at the sides of the proctodaeum. A few mesoderm cells are also found in front of the stomodaeum, below the future position of the labrum. At this stage all the cells of the embryo are still laden with yolk-granules. As development proceeds some mesoderm cells and many endoderm cells undergo cytolysis, giving rise to numerous chromatin granules, which become scattered among the yolk-spherules.

Shortly before the appearance of the caudal papilla, the naupliar mesoderm cells at the sides of the proctodaeum grow larger, and their yolk disappears (fig. 50, Pl. VIII). As the stomodaeal invagination is drawn forward (see below) these cells move into position, forming a curved row in front of, and partly surrounding, the proctodaeum. These cells form the mesodermal teloblasts, and give rise to descendants from which the mesodermal somites of the post-mandibular trunk-region are derived (figs. 51 and 52, Pl. VIII).

Much of the naupliar mesoderm retains its yolk until after the embryo has hatched.

The mesodermal teloblasts form an incomplete ring of eight cells (fig. 54, Pl. VIII). Two of the cells are situated one on each side of the mid-ventral line and between the median ectodermal teloblast and the proctodaeum. The remaining six mesodermal teloblasts are situated three on each side of the proctodaeum and towards the dorsal side. From these six teloblasts the dorsal mesoderm of the trunk somites is formed, while the two ventral teloblasts give rise to the ventral mesoderm (fig. 55, Pl. IX).

The descendants of the mesodermal teloblasts form paired blocks of mesoderm in each trunk segment from the maxillulary segment to the sixth abdominal segment inclusive. As the embryo lengthens, the pressure of the yolk-sac forces the mesodermal blocks to assume a more or less triangular shape in cross-section, and to occupy a position dorso-lateral to the nerve-cord. From its earliest formation each mesodermal somite is divisible into dorsal and ventral portions. The dorsal part of each mesodermal somite grows upward between the yolk-sac and the ectoderm. From this dorsal mesoderm are derived the dorsal vessel, pericardial floor, dorsal longitudinal muscles, and most of the mesodermal investment of the mid-gut.

The ventral part of the mesodermal somites gives rise to the ventral longitudinal muscles and the musculature of the trunk appendages.

The naupliar mesoderm extends beyond the head lobes and in front of the yolk-sac (fig. 64, Pl. XI). Here it constitutes the preantennulary mesoderm. As the embryo lengthens, some of the posterior cells of the naupliar mesoderm spread backwards (or are forced backwards by the elongating yolk-sac), and lie in the trunk segments below and at the sides of the yolk-sac (fig. 65, Pl. XI). In the posterior segments, where the yolk-sac does not press so closely against the dorsal ectoderm, some of these cells lie above it. In this position they become enclosed by the up-growing mesodermal somites, and later are found in both the cardiac and pericardial cavities (fig. 56, Pl. IX). Here and elsewhere many of them lose their yolk granules and become blood corpuscles. However, some of those lying below and at the sides of the yolk-sac become applied to it, and give rise to part of the muscular investment of the mid-gut.

The mesodermal investment of the stomodaeum is derived from the preantennulary mesoderm. Owing to the large quantity of yolk present in the embryonic tissues, I have not been able to recognize with certainty the early formation of a pair of preantennulary mesodermal somites. However, in transverse sections of a newly hatched embryo there is on each side of the stomodaeum a distinct cavity in the mesoderm. This cavity corresponds very closely with the preantennulary coelomic space of *Nebalia* (see Manton, 1934, Fig. 23, f. 1).

As mentioned above, part of the mesodermal investment of the mid-gut is formed from naupliar mesoderm that has spread backwards into the trunk. The larger portion, however, is derived from the dorsal mesoderm of the somites. As the trunk segments are formed, cells from the dorsal mesoderm grow inwards over the dorsal side of the yolk-sac, and then spread downwards to the ventral side, forming a delicate circular band surrounding the gut. During embryonic life the yolk-sac is of such wide diameter, even in the abdominal region, that complete investment by the mesoderm is not effected until after hatching. Complete investment occurs first at the junction of the mid-gut and proctodaeum, then in the preceding abdominal segments in turn from behind forwards; but even in a newly hatched specimen it is not well defined further forward than the fourth abdominal segment.

Heart and Coelomic Cavities

The development of the dorsal vessel is most clearly observed in the posterior segments, where the yolk-sac does not press so closely against the dorsal ectoderm. As each segment is formed some of the cells in the dorsal part of the mesodermal somites become oriented lengthwise to form the dorsal longitudinal muscles, others creep upward between these muscles and the yolk-sac, finally reaching the dorsal ectoderm (fig. 55, Pl. IX). The mesoderm thus growing upward on either side encloses a space above the yolk-sac. This space becomes the cavity of the dorsal vessel, and the mesodermal upgrowths its lateral walls. Part of the dorsal mesoderm also grows inward over the yolk-sac, the portions from either side meeting near the mid-line to form the floor of the dorsal vessel. In all segments the lateral walls are formed before the floor. As the yolk-sac shrinks in size, the mesoderm between it and the dorsal longitudinal muscles is pulled inward, forming a space on each side between the lateral wall of the dorsal vessel and the ectoderm. This space is the pericardial cavity, and its floor the pericardial floor (fig. 56, Pl. IX). The roof of the dorsal vessel is formed by the upper parts of the lateral walls growing inwards and meeting in the mid-line below the dorsal ectoderm. In all segments the roof is formed after the walls and the floor. In front of the second thoracic segment in a newly hatched embryo the dorsal vessel expands to form a wide cavity, roofed over by the dorsal organ, and extending forward as far as the cervical groove (fig. 57, Pl. IX).

The mesodermal roof of this cavity is not formed until some time after the dorsal organ has disappeared and the shrimp is about 4·0 mm. long.

Coelomic cavities develop early in the ventral part of the pericardial floor (fig. 59, Pl. X). During embryonic life they are compressed in most of the segments by the yolk-sac. They persist, however, until the genital rudiments are formed, and in the newly-hatched embryo they are present in the six abdominal segments, and vestiges of them still appear in the posterior thoracic segments. The coelomic space in the preantennulary mesoderm at the sides of the stomodaeum has already been mentioned.

During the last few weeks of embryonic life the anterior aorta and lateral cephalic arteries develop *in situ* as haemocoelic spaces in the preantennulary mesoderm (fig. 60, Pl. X). The mesoderm, which was originally the anterior part of the naupliar mesoderm, now lies between the yolk-sac and the brain. It is still richly supplied with yolk granules. The haemocoelic spaces extend upwards and backwards, to unite and open into the wide anterior part of the dorsal vessel underlying the dorsal organ.

In the abdominal region behind the first abdominal segment, the wall of the dorsal vessel remains thin and its lumen narrow, but in the thoracic segments the vessel becomes wider and its walls thicker, thus forming the heart (fig. 58, Pl. IX).

The sternal artery, the ventral artery, and the subneural vessel are not formed during embryonic life, and their development after hatching has not been followed.

Alimentary Canal

(*a*) *Fore-gut.* As mentioned above, the crescent-shaped ectodermal invagination giving rise to the stomodaeum is formed shortly after the differentiation of the germinal disk and before the rudiments of the naupliar appendages appear. The posterior margin of the mouth is at first higher than the anterior margin, and the invagination extends backwards in the median line almost to the proctodaeum (fig. 61, Pl. X). As the labrum is formed and begins to project over the mouth, the stomodaeal invagination becomes bent, and its inner end is drawn forward until it lies between the antero-ventral portion of the yolk-sac and the brain (figs. 62-65, Pls. X and XI). Here it soon indents the yolk-sac. The yolk-globules in the ectodermal cells forming the stomodaeal wall are gradually absorbed. By the seventeenth week the cells toward the inner end of the stomodaeum begin to form a thick columnar epithelium, which gradually extends to the outer end. However, where the stomodaeum is in contact with the yolk-sac, the cells do not form a columnar epithelium, but remain thin and flat. The thickening of the wall is accompanied by an increase in the lumen of the stomodaeum at its inner end, to form the cavity of the future cardiac division of the stomach. At the twenty-fifth week the cavity is partly filled by four longitudinal ridge-like thickenings, which project inwards from its wall, one from the dorsal surface, one from the ventral surface, and one from each side. After hatching, and when the shrimp has reached a length of 3·4 mm., the dorsal ridge is differentiated to form the median setose prominence and the two dorso-lateral ridges of the adult. The two lateral ridges in the embryo give rise to the two ventro-lateral ridges in the adult, while the ventral ridge in the embryo forms the median ventral ridge in the mature animal.

(*b*) *Mid-gut.* At the close of gastrulation the blastocoel, as mentioned above, is filled with a mass of endodermal yolk-cells, together with the primary mesoderm (figs. 48 and 49, Pl. VII). The delicate membrane surrounding each yolk-cell is discernible only under the most favourable conditions of fixation. If Carnoy's fluid be allowed to act too long the membrane is destroyed.

With the formation of the germinal disk, many of the yolk-cells on the ventral side of the endodermal mass undergo cytolysis, their nuclei disintegrating into numerous deeply-staining granules, which are scattered among the yolk-globules and finally absorbed (fig. 49, Pl. VII). Cytolysis continues until about the eighteenth week, and then diminishes in activity. During the remaining part of embryonic life, however, isolated yolk-cells may be found in which the nuclei are in process of breaking up.

The outermost cells of the endodermal mass constitute the wall of the yolk-sac, their outer ends forming the yolk-sac membrane (figs. 64-66, Pl. XI). They surround an inner core of yolk-cells, which occupy the space destined to become the lumen of the mid-gut. These inner yolk-cells seem to fuse with each other and sometimes with the inner ends of the outer cells. They are gradually absorbed as development proceeds.

As the embryo lengthens the yolk-sac extends backwards into the caudal papilla (figs. 64-66, Pl. XI). It tapers gradually from the anterior to the posterior end, there being no sudden diminution in diameter marking off a cephalo-thoracic part from an abdominal part. The cells throughout its whole length have the nature of yolk-cells, and not until just before hatching do any of them become converted into epithelial cells. Even the cells opposite the stomodaeum and proctodaeum retain the nature of yolk-cells, and do not form epithelial plates at any stage.

As the yolk in the yolk-cells is absorbed the yolk-sac shrinks in diameter, and its cells become smaller. The conversion of the yolk-cells into the epithelial cells of the mid-gut commences during the last week of embryonic life. It first occurs in the cells forming the dorsal wall of the now elongated yolk-sac, immediately in front of the proctodaeum. It then spreads round to the ventral side, advancing forward at the same time (fig. 66, Pl. XI).

Immediately after hatching, the yolk-cells at the anterior end of the yolk-sac begin to assume an epithelial nature. The indenting of the yolk-sac by the stomodaeum has helped to form a median dorsal pouch overlying the future cardiac division of the stomach. The yolk-cells forming the wall of this pouch are the first anterior cells of the yolk-sac to be converted into epithelial cells. The pouch becomes the anterior diverticulum of the mid-gut.

When the embryo hatches, the lumen of the developing mid-gut behind the fifth thoracic somite is almost empty, but in front it still contains much unabsorbed yolk. This, however, rapidly disappears, and by the time the shrimp is 2·9 mm. long communication of the mid-gut with the stomodaeum and proctodaeum is established. This is brought about by the absorption of the yolk-cells and the breaking down of the thin ectodermal septa at the points of contact.

When *Anaspides* is 3·0 mm. long all the cells forming the wall of the lengthy yolk-sac have become converted into the epithelial cells of the mid-gut. The anterior diverticulum is now well developed, and resembles that of the adult.

The rudiment of the second diverticulum of the mid-gut appears as a dorsal thickening of the gut epithelium in the first abdominal segment when the shrimp is 3·5 mm. long. The diverticulum, however, does not attain its pouch-like form until the animal is about 5·5 mm. long.

The third diverticulum is first apparent as a dorsal thickening of the mid-gut epithelium in the fifth abdominal segment of specimens about 4·0 mm. long. It develops very slowly, and does not become pouch-like until *Anaspides* reaches a length of nearly 14·0 mm.

The endodermal yolk-cells give rise not only to the mid-gut and its three diverticula, but also to the lobes of the liver. The origin of these lobes is described below.

(*c*) *Hind-gut.* A second invagination of the ectoderm to form the hind-gut does not appear to take place. The cells immediately within the lip of the blastopore form the wall of the proctodaeum, and the blastopore becomes the anal aperture. At a later stage this opening is seen to occupy a postero-dorsal position in the notch between the lobes of the caudal papilla. At first the proctodaeum is very short, and the cells forming its wall are rich in yolk-granules. At the seventeenth week the yolk has been absorbed and the cells have become epithelial. The length of the proctodaeum now increases, and its aperture moves from its postero-dorsal position into the postero-ventral position occupied by the anal aperture of the adult. The hind-gut is well developed before hatching, but, as previously mentioned, it does not communicate with the mid-gut until some time after the embryo has escaped from the egg.

The Liver

The liver-lobes are developed from the endodermal yolk-sac. The posterior pair of lobes are the first to be formed. They appear about the nineteenth week as a pair of lateral outgrowths, one on each side of the yolk-sac in the maxillary segment. The outgrowths soon grow backwards, becoming elongated and finger-like. The wall of each lobe consists of endodermal cells similar to those forming the wall of the yolk-sac. A cap of mesodermal cells covers the end of the lobes (fig. 69, Pl. XII). As the lobes lengthen their cells gradually become epithelial. The conversion takes place first at the posterior end, and then extends towards the front. The lumen of the lobes is filled with yolk-globules, which are slowly absorbed. On hatching, the posterior hepatic lobes have grown backward as far as the second thoracic segment.

Up to the twenty-second week of embryonic life the front of the yolk-sac is rounded. When, however, the dorso-ventral mandibular muscles are formed, they press against the front of the yolk-sac, forming a vertical groove or indentation on each side. The front of the sac is thus divided into a median lobe and two antero-lateral lobes. The median lobe eventually forms the anterior diverticulum of the mid-gut. The two antero-lateral lobes give rise to lobes of the liver. The apex of each antero-lateral lobe of the yolk-sac is attached to the dorsal ectoderm by a short ligament. Immediately behind the point of attachment of the ligament each lobe grows backwards as a finger-like outgrowth to form the anterior hepatic diverticula. These hepatic diverticula are anterior only in the sense that they arise from the antero-lateral lobes of the yolk-sac. They do not project towards the front, but grow towards the posterior end of the body (fig. 70, Pl. XII). They are soon followed by another pair of hepatic lobes, which arise in the same manner immediately behind the point of attachment of the dorsal ligament (fig. 71, Pl. XII). The animal usually hatches with two pairs of liver lobes, but in some cases the rudiments of a third pair are also well established. By the time the shrimp is 7·0 mm. long it has seven pairs of hepatic lobes, and when adult about fifteen pairs.

Genital Rudiment

The genital rudiment appears towards the end of embryonic life. Shortly before the embryo hatches germ-cells, having a large oval nucleus with finely granular chromatin and conspicuous nucleoli, are found on the floor of the coelomic pouches in the first and second thoracic somites. Similar germ-cells appear in succession in the coelomic pouches of the segments behind the second thoracic somite (figs. 72-73, Pl. XII). By the time the embryo hatches these segmental genital rudiments occur in the eight somites of the thorax. Soon after hatching they appear in succession in the six abdominal segments.

As each rudiment is established it grows in length by division of the germ-cells. When the animal is 6·0 mm. long the rudiments in the separate segments have united to form the long gonad of the adult. Testes and ovary develop in a similar manner. The gonoducts do not appear until much later in the life of the shrimp, and no attempt was made to follow their development.

Whether the genital rudiments in the separate somites are derived from a primary germ-cell, formed in the early stages of the segmentation of the oösperm, could not be determined. They appear, however, to be derived from the mesodermal cells forming the walls of the coelomic pouches.

Nervous System and Sense Organs

Little need be said in regard to the nervous system, which arises in much the same way as in other Crustacea. The development of the protocerebrum, with its central cell surrounded by concentric rows of other cells (fig. 68, Pl. XI), may be compared with the corresponding structure in the egg-nauplius of *Astacus* (Reichenbach, 1886, p. 29).

The median eye at its earliest appearance seems to have a paired origin. It develops from a group of cells lying between the head-lobes (fig. 67, Pl. XI). Two cells in this group, one on each side of the mid-line, give rise to pigment granules. These granules eventually collect round yolk-spheres in the cells. As the yolk is used up the pigment granules form a dense pyriform black mass. The whole structure is very rudimentary, but, like the median eye of some of the lower Decapoda, it persists as a vestigial organ for some time after hatching. In having a paired origin, the median eye of *Anaspides* resembles that of *Artemia* (Moroff, 1912, p. 18). Yolk-granules are found in the plasma of the cells forming the eye in both species. In fact, Moroff (1912, p. 17) states in reference to *Artemia* that 'der ganze Embryo ist von grösseren und kleineren Dotterkugeln erfüllt, die gleichmässig um die Zellkerne verteilt sind.' This condition is not unlike that of the egg-nauplius of *Anaspides*.

The lateral eyes in their development resemble those of *Branchipus* (Claus, 1886, p. 60). During embryonic life, and for several weeks after hatching, they are sessile. The ectoderm gradually grows in under the eyes, both from the front and the back, but it is not until the shrimp is over 4 mm. long that the pedunculated condition is attained (fig. 43, Pl. VI). Hanström (1934, p. 36) has recently shown that the paired eyes resemble those of *Mysis* in their finer structure.

The statocyst in the basal segment of the antennulary peduncle develops as an invagination of the dorsal ectodermal. The club-shaped rods arise from the ectodermal cells forming the outer wall of the invagination. In a newly-hatched embryo five rods are usually present.

The four-celled sense organ, which develops in front of the cervical groove, and which has been compared with a similar organ in the Phyllopoda both by Calman (1896, p. 787) and by Hanström (1934, p. 52), does not appear until *Anaspides* is about 4 mm. long.

In the development of the nerve cord a very distinct ganglion is formed behind that of the sixth abdominal segment. This seventh abdominal ganglion is well defined about the twenty-sixth week of embryonic life (fig. 74, Pl. XIII). As the embryo lengthens the sixth abdominal ganglion is pulled away from the fifth, leaving an intervening space in which yolk-granules collect (fig. 75, Pl. XIII). At the same time the tension on the nerve cord appears to drag the seventh abdominal ganglion into a position partly overlying the sixth. After hatching the intersegmental bar between the sixth and seventh abdominal ganglia becomes very thin (fig. 76, Pl. XIII). It finally breaks down and disappears, and the two ganglia fuse.

Musculature and Endoskeleton

A detailed examination of the development of the musculature and endoskeleton has not been made. The origin and development of the trunk musculature and gut musculature have been briefly mentioned in other parts of this paper. The endoskeleton of *Anaspides*, like that of *Nebalia* (Manton, 1934, p. 202), is formed from intersegmental ectodermal bars which arise from lateral and ventral intuckings. These bars are strongly developed in the mandibular, maxillulary, and maxillary segments. The rudiment of the mandibular bar appears at about the fifteenth week. The other bars are developed in sequence. The greater part of the endoskeleton in the region of the mouth is formed from the first three post-oral bars. These bars are all nucleated, and remain nucleated even in the adult.

A critical study of the endoskeletons of *Anaspides*, *Paranaspides*, *Nebalia*, *Hemimysis*, and *Nyctiphanes* has already been made by Dr. Manton. As a result of this study the close similarity existing between the endophragmal structures of the Syncarida and Leptostraca has been demonstrated (Manton, 1934, p. 220). This similarity is further emphasized by the close agreement in the mode of development.

Maxillary Gland

The rudiment of the maxillary gland appears about the middle of embryonic life. Mesoderm cells begin to form a compact group on each side of the nerve cord in the maxillary somite (fig. 77, Pl. XIII). Yolk granules in the vicinity of these cells are rapidly absorbed. At first no definite arrangement of the cells can be observed, but as development proceeds the nuclei of the cells become oriented to form more or less regular transverse rows, giving rise to the tubules of the gland (fig. 78, Pl. XIII). The end-sac of the gland soon appears as a large cavity in the group of mesoderm cells. From the gland a duct leads downward in front of the large transverse adductor muscle in the basal segment of the maxilla, curves under the muscle, and eventually opens near the centre of the posterior surface of the appendage (fig. 79, Pl. XIII). Smith (1909, p. 537), in describing the adult animal, states that the duct 'opens by a pore on the external border of the appendage'. This, however, is not the case. Sections through the maxilla of a mature specimen show quite clearly that the duct opens by a pore on the posterior surface. Just before hatching a small invagination of the ectoderm occurs at this spot, and communicates with the duct from the gland. With the exception of this ectodermal lining of the aperture, the whole of the gland and its duct are derived from mesoderm, and are fully developed on hatching (fig. 80, Pl. XIII).

Median Dorsal Organ

The median dorsal organ is not to be confused with the four-celled sense organ, which, in young adults, appears in a median position in front of the cervical groove, and which Calman (1909, p. 164) states 'may be comparable to an obscure "dorsal organ"'. The four-celled sense organ does not develop for some time after hatching, whereas the median dorsal organ appears at about the twenty-first week of embryonic life. It consists of a marked thickening of the dorsal ectoderm, extending from behind the eyes to the front of the second thoracic segment. The ectodermal cells composing it are long and columnar, but become smaller round the margin of the organ. At first the cells contain yolk-globules, and their boundaries are distinct. As development proceeds the cells degenerate, their walls break down, and in some cells the nuclei disintegrate. In the living embryo the organ has a yellowish colour, and is quite conspicuous. It persists for some time after hatching, but has disappeared by the time the animal is 3·5 mm. long.

Habits of Anaspides

The newly-hatched animal moves about actively, sometimes crawling over rocks and débris at the bottom of the water, at other times swimming up to the surface. If it is gently touched when swimming, it will often sink to the bottom, and, lying on its back with its body stretched out in a passive state, remain as if dead for several seconds. This death-feigning habit occurs only in the newly-hatched animal, and is not exhibited by the adult. Herrick (1895, p. 184) has described a similar peculiarity in young specimens of *Homarus americanus*.

Smith (1909, p. 546) states that *Anaspides* 'will occasionally rise to the surface of the water and turn over on its back in the manner of a Phyllopod'. I am able definitely to confirm the accuracy of this observation. In quiet pools at the side of the mountain stream, where the water is not disturbed by ripples, *Anaspides* often comes to the surface, turns over on its back, and, moving about on the underside of the surface-film, searches for food among the small particles which are floating there. The habit is observed more frequently in young than in adult animals, since the weight of the latter is not so easily supported by the surface tension of the water. Small specimens (5·0 mm. long) not only move about on the under side of the surface-film, but also rest there in an inverted position. I have observed specimens resting in this way for over ten minutes.

The animal does not commence feeding until communication between fore-gut, mid-gut, and hind-gut is established. This occurs a few days after hatching. When the young shrimp begins feeding a long cylindrical tube, about equal in length to the mid-gut, is extruded from the anal aperture, and is carried about for some time before being expelled. This tube is probably composed of the inner ends of the yolk-cells forming the wall of the mid-gut, and is cast off when these cells become epithelial. It is certainly not the ectodermal lining of the hind-gut, which is comparatively short, and is cast off during ecdysis.

Mating has not been observed. However, male specimens in the creek are sometimes seen employing the armed basal joint of the inner antennulary flagellum in an attempt to seize hold of the base of one of the antennules in a female.

Discussion

Segmentation of the Egg

The egg of *Anaspides*, like that of *Lucifer* (Brooks, 1882, p. 64), exhibits complete and equal cleavage. In both a large segmentation cavity is formed, and into this cavity, shortly after the sixteen-celled stage has been reached, a blastomere moves. In *Lucifer* this blastomere divides as it passes inwards. In *Anaspides* it divides after it has entered, and at the same time other blastomeres appear to pass inwards. There is then formed in each case a deep invagination-gastrula with a primitive archenteric cavity. At first all the cells are equally provided with yolk, but at the commencement of invagination in *Lucifer* the yolk has largely disappeared from all cells except those in the segmentation cavity. The cells of *Anaspides* are laden with yolk granules up to a late stage in development.

Brooks (1880, p. 563) originally regarded the cells lying in the segmentation cavity of *Lucifer* as mesoderm cells. In a later publication (Brooks, 1882, p. 70) he abandoned this opinion in favour of the view that they were yolk pyramids, because they were charged with yolk granules. Unfortunately the subsequent history of these cells was not followed. The corresponding cells in *Anaspides* constitute the primary mesoderm.

Ectodermal and Mesodermal Teloblasts

The trunk region of *Anaspides*, like that of the Leptostraca Peracarida, and Decapoda, is formed from rows of ectodermal and mesodermal teloblasts developed immediately in front of the blastopore. The teloblastic regions of *Hemimysis* and *Nebalia* have been described in detail by Dr. Manton (1928, p. 370; and 1934, p. 178). *Anaspides* agrees with both these forms in possessing an ectodermal teloblast in the mid-ventral line. It has been suggested by Dr. Manton (1934, p. 212) that 'possibly the Decapoda differ from the Peracarida in possessing no mid-ventral ectodermal teloblast'. Sollaud (1923, p. 93) gives a figure of the teloblastic region of *Leander* in which a mid-ventral teloblast is clearly indicated. It is highly probable that a mid-ventral teloblast will be found in all those Crustacea in which teloblastic development of the trunk occurs.

In *Anaspides*, *Nebalia*, and the *Decapoda* the ectodermal teloblasts form a complete ring around the caudal papilla. In both *Anaspides* and *Nebalia* the ring consists of 19 teloblasts.

Four pairs of mesodermal teloblasts are present in *Anaspides*, *Nebalia*, and *Hemimysis*. Patten (1890, p. 371) records a similar number in *Cymothoa*.

External Form

In the development of the external form of the body, and in the order in which the appendages appear, *Anaspides* resembles the Leptostraca and Mysidacea. Owing, however, to the much later rupture of the egg-envelopes, the ventral flexure of the body, like that in the Decapoda, is retained until the embryo is hatched. The strong development of both rami of the second antenna during early embryonic life, followed by the gradual degeneration of the exopodite, recalls the similar changes through which this appendage passes in the larval life of certain Decapoda. Thus in the protozooea of *Penaeus* the second antenna has a three-jointed endopodite and a four-jointed exopodite, but by the time the mysis stage is reached, the exopodite has degenerated into a scale (Müller, 1863, p. 8; and Claus, 1876, p. 11).

In the newly-hatched *Anaspides* the notched telson, with its six pairs of setae, bears some resemblance to that of a protozooea, and perhaps indicates that the ancestors of *Anaspides* passed through some such larval stage.

The Heart and Coelomic Sacs

In its main features the development of the heart resembles that of *Hemimysis* and *Nebalia*. In *Nebalia*, however, the ventral wall of the dorsal vessel appears first, and later the sides and roof, whereas in *Hemimysis* and *Anaspides* the lateral walls are first formed, and then the floor, followed by the roof. As in *Hemimysis*, the pericardial floor is formed from the dorsal mesoderm as it grows upward, and not, as in *Estheria*, by a later downward growth of the dorsal mesoderm.

Coelomic sacs have been demonstrated in *Estheria* (Cannon, 1924, p. 425), *Chirocephalus* (Cannon, 1926, p. 402), *Hemimysis* (Manton, 1928, p. 397), and *Nebalia* (Manton, 1934, p. 227). In *Anaspides*, as in *Hemimysis* and *Chirocephalus*, the coelomic sacs are early compressed between the yolk-sac and developing pericardium, but while in *Chirocephalus* they are soon obliterated, in *Anaspides* and *Hemimysis* they persist throughout embryonic life. In *Anaspides* they are large, and most clearly seen in the newly-hatched embryo, when the yolk-sac is somewhat shrunken, and the trunk, released from its flexed condition, has straightened out. The large size of these coelomic sacs is a primitive character comparable to that in *Estheria* (Cannon, 1924, p. 395).

Alimentary Canal

The position of the anus relative to the blastopore has been reported differently by different authors (see Korschelt and Heider, 1899, p. 173). As pointed out by Dr. Manton (1928, p. 431), it is not always possible to determine with accuracy the relative positions of these two structures, ‘ since the blastopore may be a vague area and is obliterated before the anus appears ’. In *Anaspides*, however, the blastopore is a very definite aperture leading into an archenteric cavity. Although the lumen of this cavity is eventually rendered imperceptible by the crowding together of the endoderm cells, the blastopore is always well defined. It becomes the anal aperture, and the cells immediately within its lip give rise to the proctodaeum.

A critical account of the development of the mid-gut in Crustacea has recently been given (see Manton, 1928, pp. 433-436). A repetition of this account is not needed, but it may be said that generally in the centrolecithal eggs of Crustacea certain cells pass inward from the blastoporal area, absorb yolk, and form yolk-cells, which give rise partly or entirely to the mid-gut. In *Hemimysis* these yolk-cells spread around the yolk, and form the yolk-sac. Later they are transformed into the epithelial cells of the mid-gut. In *Nebalia* the yolk-sac is at first composed of yolk-cells connected posteriorly with an epithelial endodermal plate. By proliferation of its own cells and transformation of the yolk-cells along its margin, this plate gradually extends forward until all the yolk is enclosed in an epithelial yolk-sac. A similar process probably takes place in *Leander* (see Sollaud, 1923, p. 162). In *Anaspides*, as in *Cetochilus* (Grobben, 1881, p. 243), the cells forming the archenteric invagination are heavily laden with yolk, and are virtually yolk-cells. They give rise directly to the yolk-sac, and later to the mid-gut. In *Cetochilus*, however, the lumen of the invagination persists, whereas in *Anaspides* it is obliterated by some of the yolk-cells crowding into its centre and forming a central core. This condition, although originating in a different way, is similar to that appearing in *Hemimysis* after the yolk-cells have formed the secondary yolk-pyramids. The outer cells of the endodermal mass in *Anaspides* form the yolk-sac, and correspond to the secondary yolk-pyramids of *Hemimysis*, while the inner core of cells in *Anaspides* corresponds to the central core of yolk in *Hemimysis*. In both, the cells forming the yolk-sac become transformed into the epithelium of the mid-gut, the transformation taking place first opposite the stomodaeum and proctodaeum, but somewhat earlier in *Hemimysis* than in *Anaspides*.

Cytolysis occurs only to a small extent in the yolk-cells of *Hemimysis*, but largely in those of *Anaspides*. Degeneration of the yolk-cells occurs extensively in many Decapoda, and has been recorded in *Alpheus* (see Brooks and Herrick, 1892, p. 425), *Homarus* (see Herrick, 1895, p. 211), and *Leander* (see Sollaud, 1923, p. 83).

The Liver

The liver, or hepatopancreas, of the Crustacea does not always develop in the same way. In *Hemimysis* the posterior liver-lobes 'arise independently of the yolk-sac from a pair of epithelial plates of mesoderm which grow round the yolk-sac' (see Manton, 1928, p. 433). In *Anaspides* these lobes are formed as out-pushings of the yolk-sac, which open latero-ventrally into the mid-gut immediately behind the stomodaeum. Sollaud (1923, p. 171) has described a somewhat similar origin for the liver-lobes of *Leander*. The hepatic diverticula of *Nebalia* also develop as outgrowths of the endodermal yolk-sac (see Manton, 1934, p. 183).

The anterior hepatic lobes of *Anaspides* arise in much the same way as those of *Nebalia*, except that the yolk-sac is indented not by a single median depression but by two vertical furrows, one on each side of the anterior mid-gut diverticulum. Moreover, the anterior lobes do not extend forward into the head, but curve over and grow towards the tail, the primary pair of lobes being soon followed by a second pair, which develop at the point where the first pair bend over.

Maxillary Gland

The maxillary gland of *Anaspides*, like that of *Estheria* (Cannon, 1924, p. 424) and *Chirocephalus* (Cannon, 1926, p. 406), is of mesodermal origin. As in *Chirocephalus*, the end-sac and primordia of the coils appear early. The close similarity in the adult pattern of the maxillary glands of *Chirocephalus* and *Anaspides* has already been demonstrated (see Cannon and Manton, 1927, p. 445). It is not surprising, therefore, to find a similarity in their mode of development.

Genital Rudiment

In *Anaspides*, as in *Nebalia*, the gonads arise in the walls of the coelomic pouches at a late stage in embryonic life. Dr. Manton has already pointed out that, in this respect, *Nebalia* resembles the Annelids, *Peripatus* (Sedgwick, 1887, p. 467) and *Scolopendra* (Heymons, 1901, p. 1). A similar origin of the gonads is also found in spiders, *Limulus*, and other Arthropoda.

Hatching Process and Habits

There is a remarkable similarity in the hatching of *Anaspides* and that of certain Cladocera. The winter-egg of *Daphnia* has no chorion, but is surrounded by a primary yolk membrane or 'Dotterhaut', which corresponds to the vitelline membrane in the egg of *Anaspides*. Below this membrane, during the development of both *Daphnia* and *Anaspides*, two larval integuments are formed. The first appears at the egg-nauplius stage. It becomes strong, elastic, and semipermeable. The second appears somewhat later, and is consequently within the first. Now Volmer (1912, p. 646) has shown that the first larval integument is of the greatest importance in the hatching of *Daphnia*. By osmosis it absorbs water, and swells out like a balloon, bursting first the 'Dotterhaut,' and then the ephippium. In *Anaspides* it behaves in a similar manner, bursting first the vitelline membrane, then the chorion. In each case a long time elapses before the balloon-like structure breaks, liberating the embryo. During this time *Anaspides* throws off the second larval integument.

According to the observations of Spangenberg, quoted by Oehmichen (1921, p. 242), it appears that the larva of *Branchipus* is also surrounded by an expanded transparent investment during hatching.

Anaspides not only resembles the Cladocera in its method of hatching, but also in its habit, when young, of moving about in an inverted position on the under-side of the surface film in calm water. Wagler (1927, p. 353) gives a figure of *Scapholebris* in such a position.

The eggs of *Anaspides* laid during winter resemble the winter-eggs of the Cladocera in going through the early stages of segmentation soon after laying, and then entering upon a long period of dormancy.

CONCLUSIONS

From the above discussion it is clear that *Anaspides* shows in its development a close resemblance to the Leptostraca as exemplified by *Nebalia*, the main points of agreement being the following:

(1) The origin and number of ectodermal teloblasts.
(2) Presence of a mid-ventral ectodermal teloblast.
(3) Formation of a complete ring of nineteen ectodermal teloblasts around the caudal papilla.
(4) Presence of four pairs of mesodermal teloblasts.
(5) Irregular nature of the naupliar mesoderm.
(6) Development of the post-mandibular segments from before backwards.
(7) Origin of the liver lobes from the endodermal yolk-sac.
(8) Essential features of the development of the dorsal vessel.
(9) The late appearance of the genital rudiments in the coelomic pouches.
(10) Presence of a similar type of median dorsal organ, which eventually degenerates.
(11) Absence of a free-swimming larval stage.

In points (1), (2), (4), (5), (6), (8), (10), and (11), *Anaspides* and *Nebalia* both resemble the Peracarida.

Although in *Anaspides* the stages of development following differentiation of the germinal disk are mainly Malacostracan in character, the early stages, as in the case of *Lucifer*, bear some resemblance to those of certain Entomostraca. Thus the holoblastic segmentation, followed by the formation of a relatively large blastocoel, recalls the similar stages in the Copepod *Cetochilus*, and also in the Branchiopods *Branchipus* and *Bythotrephes*. The development of an invagination-gastrula, giving rise directly to the mid-gut, is a very primitive condition also seen in *Cetochilus*.

Anaspides also resembles the Branchiopoda in the following respects:

(1) Origin and development of the maxillary gland.
(2) Long persistence of yolk granules in the embryonic tissues.
(3) The prolonged dormancy of the embryo in winter eggs.
(4) The mode of hatching.
(5) The habit of moving about in an inverted position on the under-side of the surface-film in calm water.

SUMMARY

1. *Anaspides tasmaniae* Thomson lays its eggs singly on moss, bark, and other forest débris in the mountain tarns and streams of Tasmania.

2. Egg-laying goes on throughout the year, but is most active during October and November.

3. Eggs laid in the spring and summer hatch in about 32 to 35 weeks. Those laid in autumn and winter undergo the early stages of segmentation, and then become dormant until spring.

4. Hatching takes place in the winter months, June to October.

5. Segmentation is holoblastic, and a large blastocoel is developed.

6. The primary mesoderm is formed by migration of blastomeres into the blastocoel.

7. The formation of the primary mesoderm is followed by the development of a deep invagination-gastrula with a temporary archenteric cavity.

8. The invagination-gastrula gives rise directly to the endodermal yolk-sac, and later the mid-gut. Most of the endoderm cells do not become epithelial in nature until after hatching.

9. Marked cytolysis occurs in the endodermal cells, and also to some extent in the primary mesoderm.

10. A typical V-shaped germinal disk is formed, and gives rise to an egg-nauplius of the usual type. All the cells of the embryo at this stage are laden with yolk granules.

11. The caudal papilla is surrounded by a ring of nineteen ectodermal teloblasts, which give rise to all the post-mandibular segments of the trunk.

12. A mid-ventral ectodermal teloblast is present.

13. The naupliar mesoderm and four pairs of mesodermal teloblasts are derived from the primary mesoderm.

14. The mesodermal teloblasts form paired mesodermal somites, which give rise to the dorsal vessel, the pericardium, the longitudinal muscles of the trunk, the muscles of the post-mandibular appendages, and part of the gut musculature.

15. Coelomic cavities appear in the pericardial floor, and persist until after hatching.

16. The genital rudiments develop in the walls of the coelomic cavities towards the end of embryonic life.

17. The maxillary gland is of mesodermal origin, and appears at an early stage.

18. The liver lobes are formed as outpushings of the endodermal yolk-sac.

19. The presence of a rudimentary seventh abdominal segment, which becomes fused with the sixth, is indicated by the number of ganglia in the embryonic nerve cord.

20. A median dorsal organ is present, and persists for some time after hatching.

21. Yolk granules are found in the tissues of the embryo until a late stage of development.

22. The process of hatching resembles that of the Cladocera.

23. The newly-hatched *Anaspides* differs from the adult in having a rudimentary median eye, sessile paired eyes, no rostrum, a forked telson, no endopodites on any of the appendages of the first five abdominal segments, and no external sex organs.

24. The habits of the young *Anaspides* resemble those of certain Cladocera.

25. A comparison of the development of the Syncarid with that of the Leptostraca, Peracarida, Branchiopoda, and Copepoda is made.

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PLATE I

Fig. 1.—Eggs of *Anaspides tasmaniae* Thomson attached to a piece of bark from one of the boxes placed in the creek. × 10.

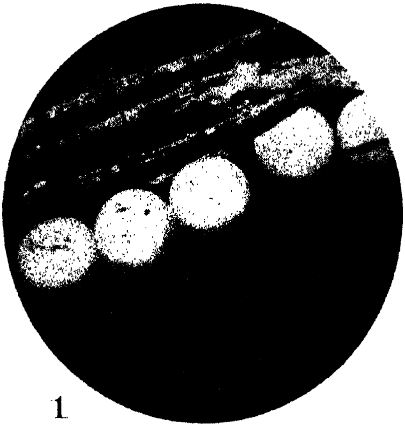
Fig. 2.—*Anaspides* surrounded by the distended first larval integument during the process of hatching. The broken chorion is seen at the left of the figure. The second larval integument is not yet cast off. × 10.

Fig. 3. Male and female pronuclei in contact near the centre of the unsegmented egg. × 400.

Fig. 4.—Male and female pronuclei becoming rounded off preparatory to fusion. × 300.

Fig. 5.—Two-celled stage surrounded by the transparent chorion. × 40.

Fig. 6.—Two-celled stage surrounded by the chorion. The blastomeres almost separated by the first cleavage. × 40.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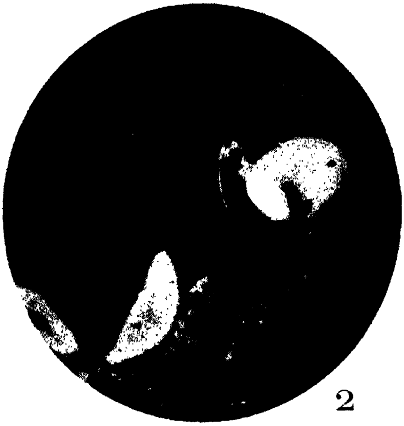
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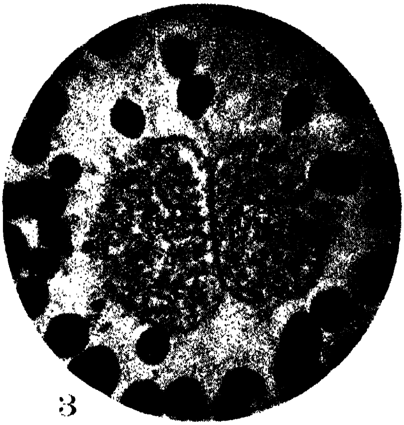
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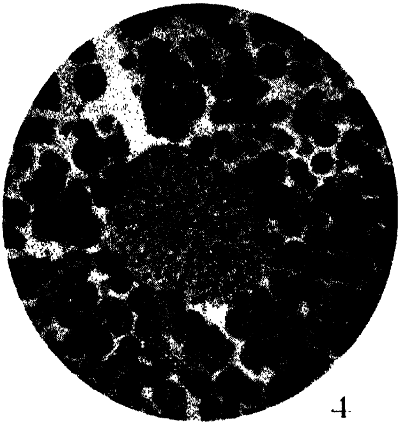
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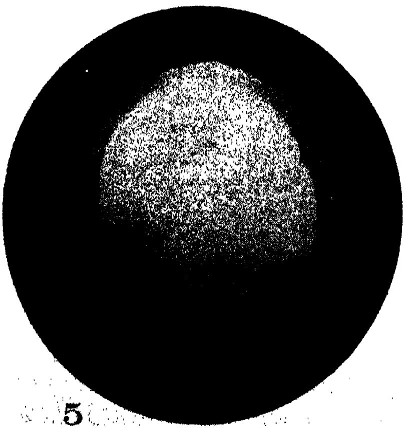
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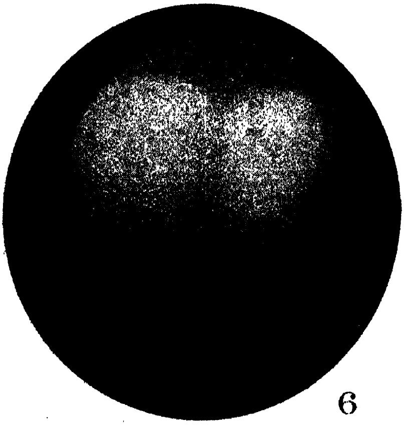
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PLATE II

Fig. 7.—Two-celled stage in which the two blastomeres have partially refused.

Fig. 8.—Section through the stage shown in fig. 7.

Fig. 9.—Four-celled stage.

Fig. 10.—Equatorial section through the four-celled stage.

Fig. 11.—Eight-celled stage.

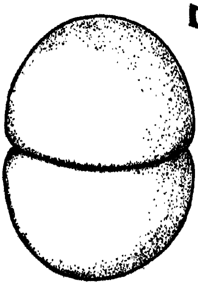
Fig. 12.—Sixteen-celled stage.

Fig. 13.—Section through an embryo immediately after the sixteen-celled stage, showing a blastomere entering the blastocoel.

Fig. 14.—Section through a slightly later stage than that shown in fig. 13. The blastomere is now in the blastocoel, and is undergoing mitosis to form the primary mesoderm.

Fig. 15.—Section through a stage more advanced than that shown in fig. 14. The blastocoel is much larger, and now contains a number of primary mesoderm cells.

Fig. 16.—Section through a stage just prior to gastrulation.



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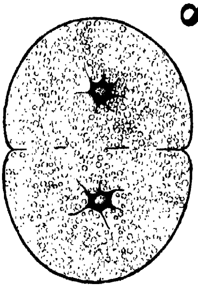

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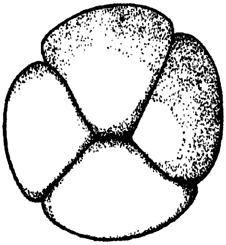

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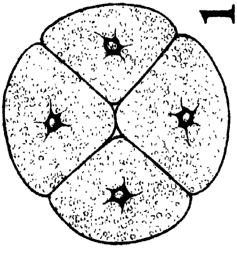

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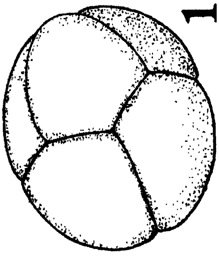

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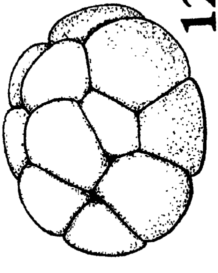

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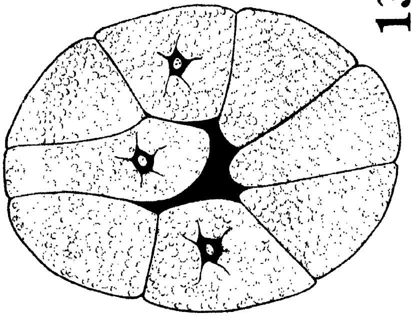

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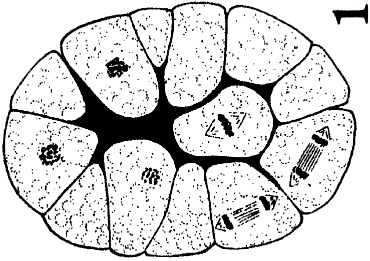

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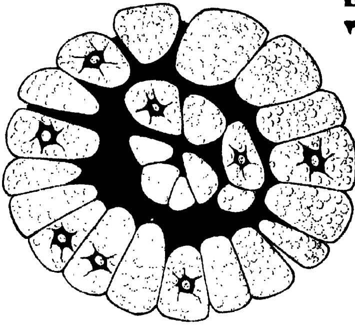

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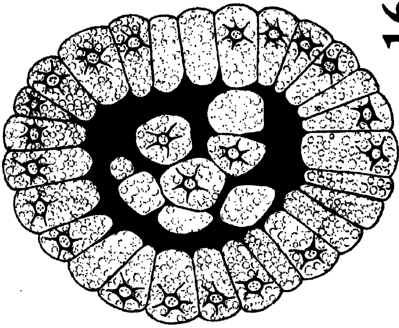

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PLATE III

Fig. 17.—Surface view of embryo shortly after the commencement of invagination.

Fig. 18.—Surface view of embryo towards the close of invagination.

Fig. 19.—Sagittal section through embryo at the commencement of invagination.

Fig. 20.—Sagittal section through an embryo during invagination, showing the formation of a temporary archenteric cavity.

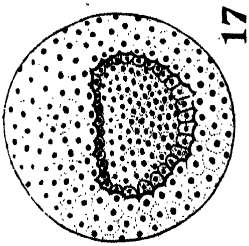
Fig. 21.—Ventral view of an embryo stained with alum-carmine to show the V-shaped germinal disk.

Fig. 22.—Dorsal view of embryo at the same stage as that shown in fig. 21.

Fig. 23.—Ventral view of egg-nauplius at about the ninth week of summer-development. Drawn from a whole mount stained with alum-carmine.

Fig. 24.—Ventral view of egg-nauplius at about the tenth week, showing partial contraction of the disk and the formation of labrum and head-lobes.

*a.*1., antennule
*a.*1.*g.*, antennulary ganglion
*a.*2., antenna
*a.*2.*g.*, antennary ganglion
a.c., archenteric cavity
bl., blastopore
c.l., cephalic lobe or optic lobe
c.p., caudal papilla
en., endodermal cell
lb., labrum
m., primary mesoderm
md., mandible
md.g., mandibular ganglion
pr., proctodaeum
st., stomodaeum



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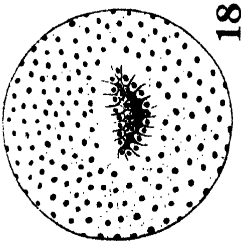

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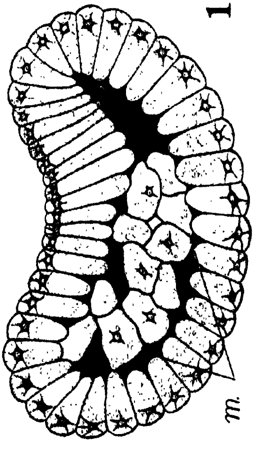

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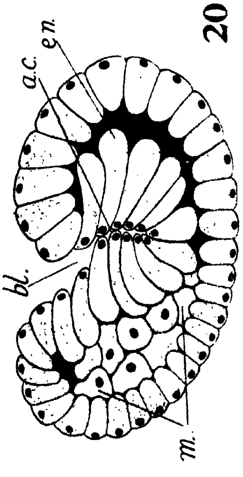

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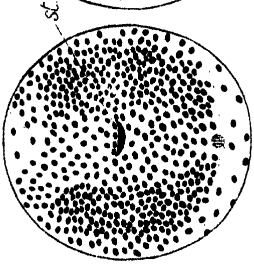

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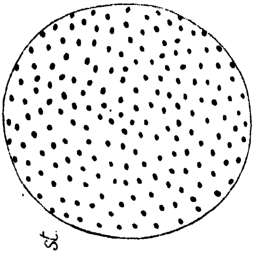

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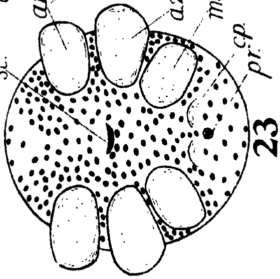

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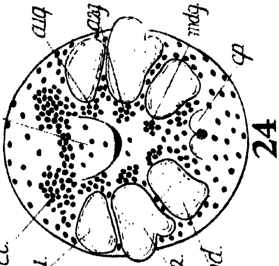

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PLATE IV

Fig. 25.—Surface view of region in the vicinity of the blastopore at the first appearance of the ectodermal teloblasts. Drawn with the aid of a camera lucida from a whole mount stained with alum-carmine.

Fig. 26.—Surface view of blastoporal region when, by the contraction of the disk, the naupliar appendages have come closer together and the row of ectodermal teloblasts has commenced to curve round the caudal papilla. (See also fig. 28.)

Fig. 27.—Ventral view of egg-nauplius at the eleventh week. The disk has now contracted to such an extent that the appendages no longer project beyond the sides of the embryo. The cells of the head-lobes now form concentric circles.

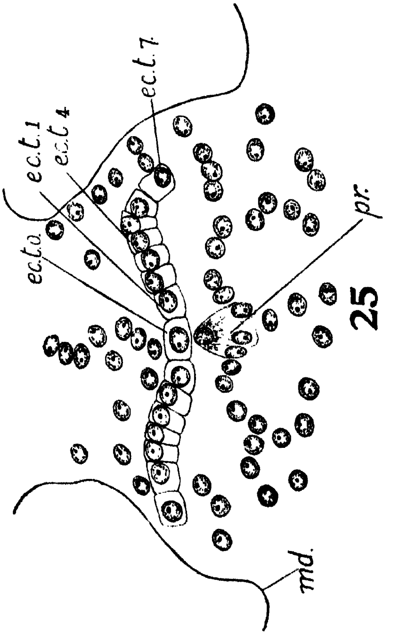
Fig. 28.—Ventral view of embryo at the thirteenth week. The caudal papilla is now well formed.

Fig. 29.—Ventral view of embryo at the fifteenth week. Median eye and the rudiments of the maxillules have now appeared.

Fig. 30.—Ventral view of embryo at the sixteenth week. Endopodite and exopodite of the antennae are now segmented and about equal in length.

a.1., antennule
a.2., antenna
c.c., central cell of head-lobe
c.l., head-lobe
c.p., caudal papilla
ec.t., ectodermal teloblast
*ec.t.*0., median ectodermal teleblast
*ec.t.*1.,-*ec.t.*7., lateral ectodermal teloblasts

lb., labrum
m.d., mandible
m.e., median eye
*mx.*1., maxillule
*mx.*2., maxilla
pr., proctodaeum
*th.l.*1., first thoracic appendage
*th.l.*3., third thoracic appendage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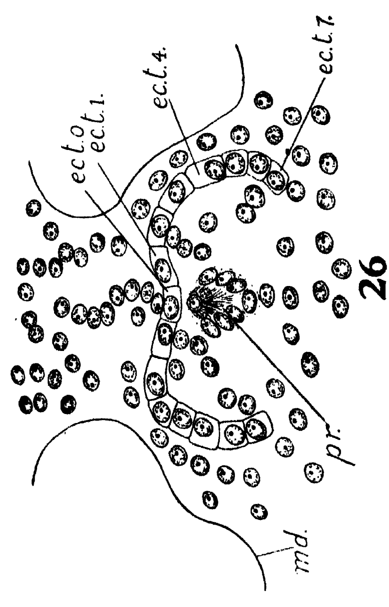
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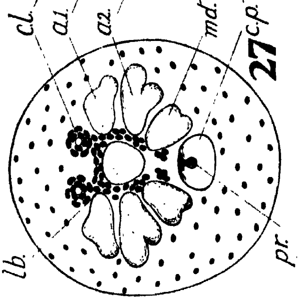
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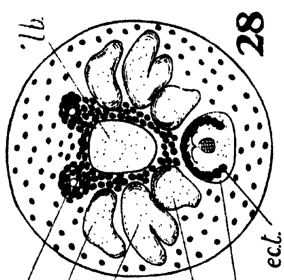
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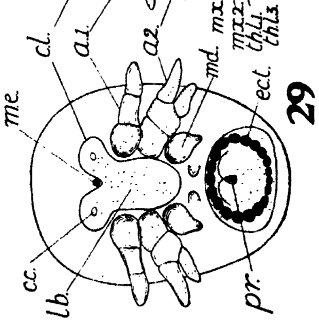
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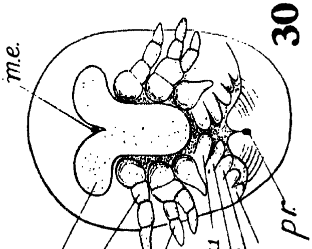
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PLATE V

Fig. 31.—Optical section of egg just before hatching, showing the embryo surrounded by the chorion, vitelline membrane, and first and second larval integuments.

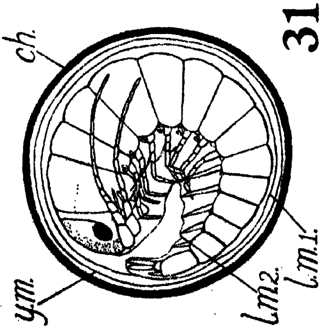
Fig. 32.—Egg at first stage of hatching, showing split in chorion.

Fig. 33.—Second stage in the hatching process. The first larval integument is bulging out through the split in the chorion, forcing it open.

Fig. 34.—Final stage in hatching. The chorion has burst, and the shrimp is now surrounded by the distended first larval integument, to the outer surface of which portions of the vitelline membrane still adhere. The second larval integument has been cast off, and lies within the first.

Fig. 35.—The newly hatched shrimp, showing the sessile eyes, the two pairs of hepatic lobes, and the elongated yolk-sac. The latter is clearly seen through the transparent ectoderm and muscles of the animal.

ch., chorion
l.m.1., first larval integument
l.m.2., second larval integument
v.m., vitelline membrane



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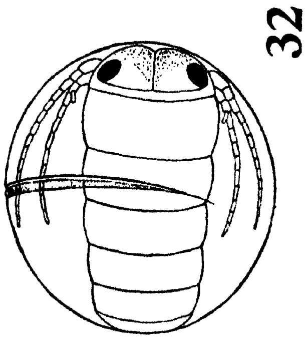

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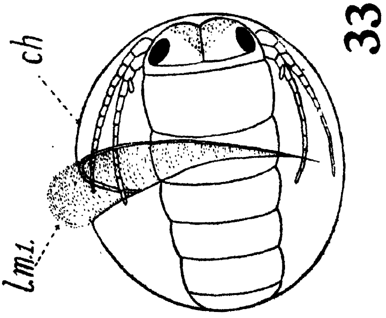

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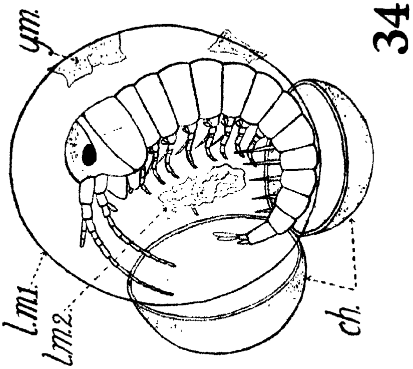

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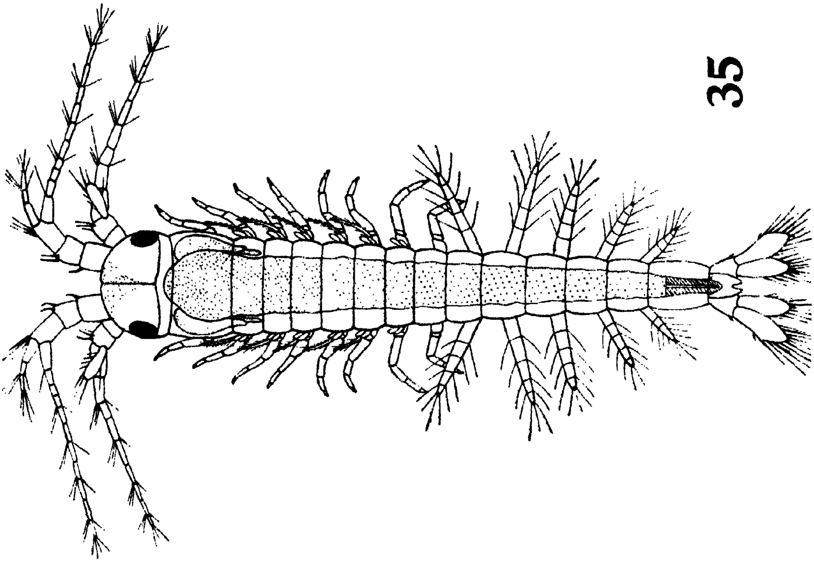

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PLATE VI

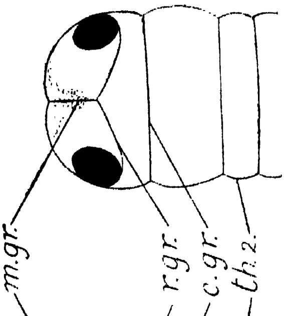
Figs. 36-39.—Appendages of the newly hatched *Anaspides:*

Fig. 36.—Antennule.
Fig. 37.—Antenna.
Fig. 38.—Third thoracic appendage.
Fig. 39.—Mandibles.

Figs. 40-43.—Dorsal views of the head region in young specimens of ***Anaspides*** to show the gradual development of the rostrum and of the pedunculated condition of the paired eyes:

Fig. 40.—Newly hatched specimen.
Fig. 41.—Specimen about 3·4 mm. long.
Fig. 42.—Specimen about 4·4 mm. long.
Fig. 43.—Specimen about 4·6 mm. long

c.gr.. cervical groove
c.s.o., four-celled cervical sense organ
m.gr., median longitudinal groove of head
r., rostrum
r.gr., rostral groove
th.2., second thoracic segment



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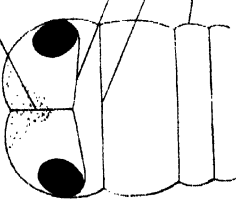

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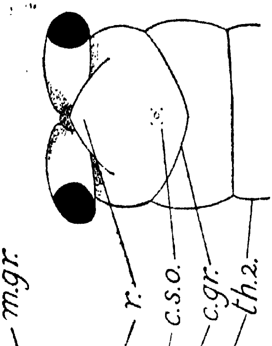

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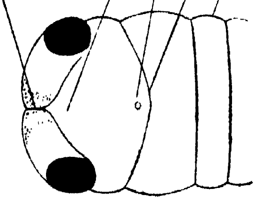

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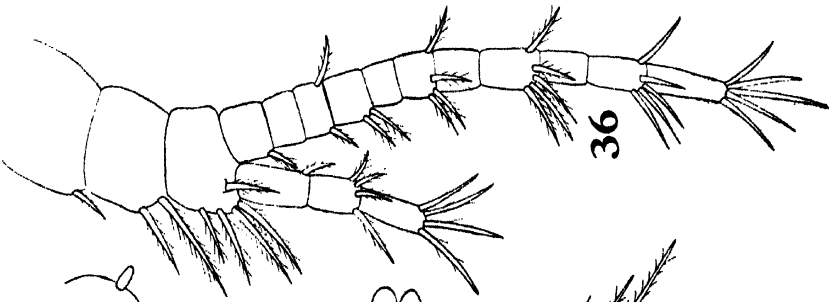

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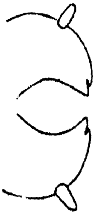

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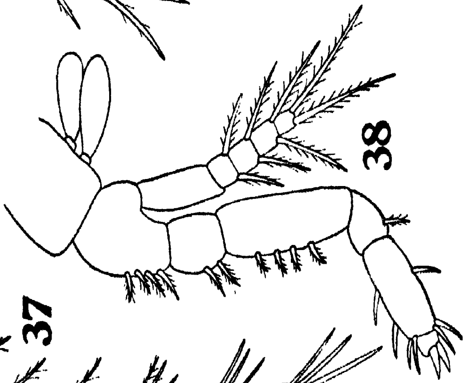

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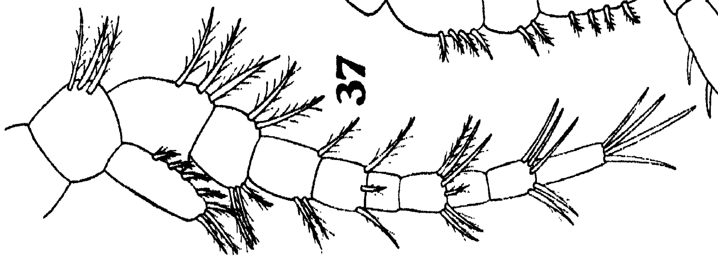

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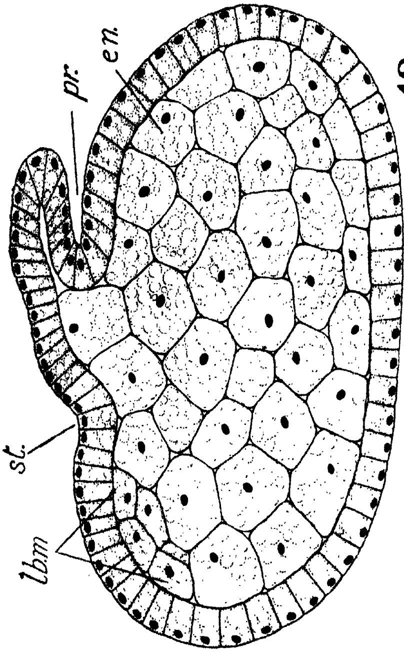
PLATE VII

Figs. 44-47.—Appendages and telson of the newly hatched *Anaspides:*
- Fig. 44.—Uropods and the notched telson.
- Fig. 45.—Third abdominal pleopod.
- Fig. 46.—Maxilla.
- Fig. 47.—Maxillule.

Fig. 48.—Sagittal section through an embryo at a stage immediately following gastrulation and just before that shown in fig. 21. The endodermal cells have crowded together, and now fill most of the blastocoel. The blastopore is closing, and the cells within its margin form the wall of the proctodaeum. The stomodaeal invagination is commencing. A few mesoderm cells appear below the future position of the labrum.

Fig. 49.—Transverse section of an embryo at the stage shown in fig. 23. The section passes through the opening of the stomodaeum. The strands of mesoderm on each side are seen in cross-section below the rudiments of the antennae. Cytolysis has occurred in some of the endodermal cells, giving rise to granules of chromatin.

a.2., antenna
en., endodermal cell
lb.m., labral mesoderm
n.m., naupliar mesoderm
pr., proctodaeum
st., stomodaeum



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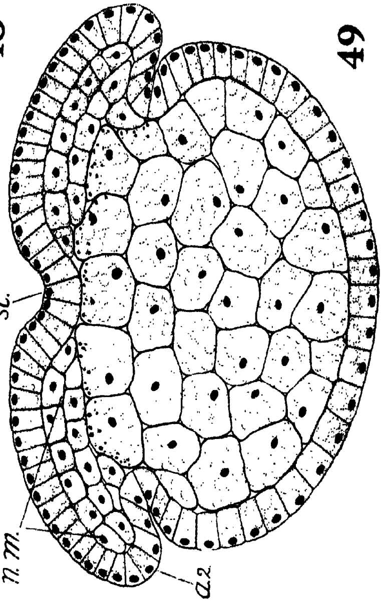

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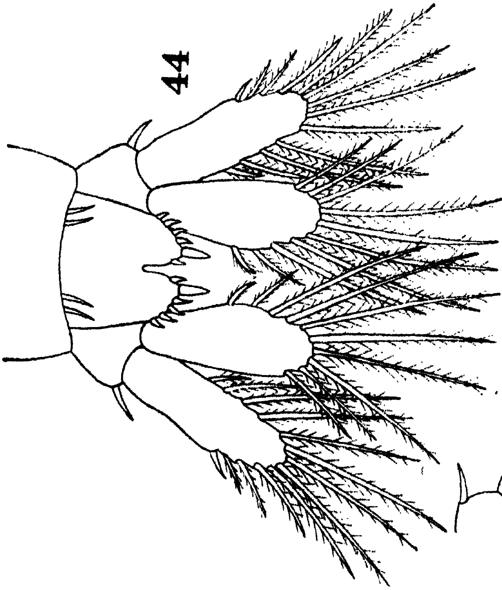

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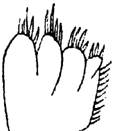

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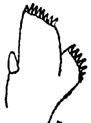

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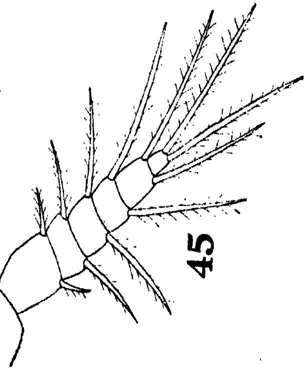


45

PLATE VIII

Fig. 50.—Transverse section of early egg-nauplius passing through the anterior lip of the blastopore. The cells of the posterior ends of the mesodermal strands lie on each side of the proctodaeum. These cells give rise to the mesodermal teloblasts.

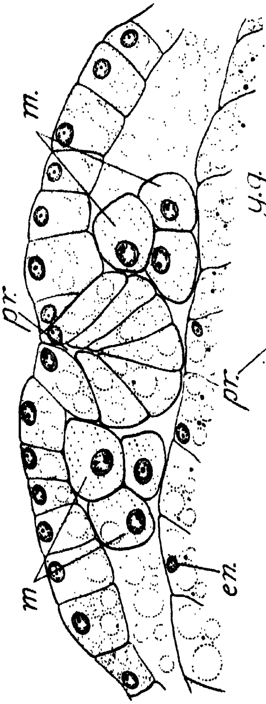
Fig. 51.—Transverse section through the stage shown in fig. 27. The section passes through the caudal papilla, and shows a mesodermal teloblast and its first descendant on each side of the proctodaeum.

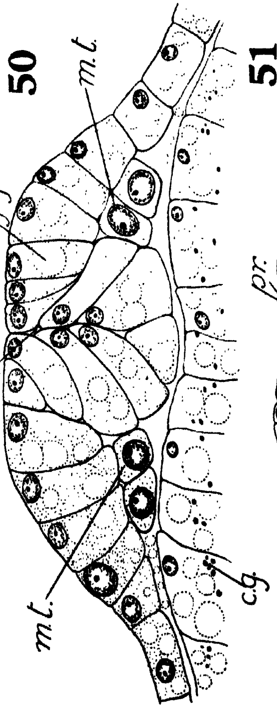
Fig. 52.—Transverse section of the nauplius stage shown in fig. 28. The section passes through the caudal papilla, and shows in cross-section on each side the ring of ectodermal teloblasts and two rows of descendants. The mesodermal teloblasts have also given rise to two rows of descendants.

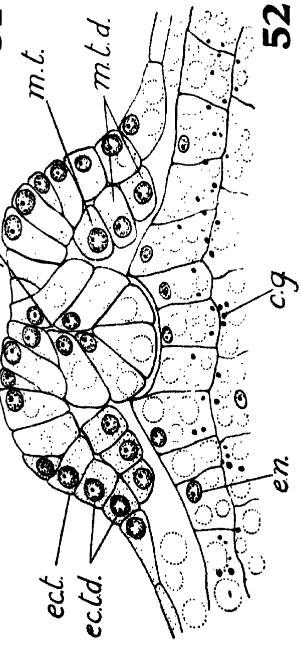
Fig. 53.—Transverse section of the tip of the caudal papilla of an embryo at about the fifteenth week of development. At this stage the papilla cannot be removed from the embryo without injury, and hence had to be sectioned *in situ*. Orientation is not quite correct, and the section is somewhat oblique. It shows the median ectodermal teloblast and several of the lateral ones. The small cells forming the telson mesoderm also appear in the section.

Fig. 54.—Transverse section of the caudal papilla of another embryo of about the same age as that shown in fig. 53. The section is slightly more anterior than that of fig. 53, and shows the four pairs of mesodermal teloblasts and descendants of some of the ectodermal teloblasts.

c.g., chromatin granules
ec.t., ectodermal teloblast
ec.t.0., median ectodermal teloblast
ec.t.1.,-ec.t.9., lateral ectodermal teloblasts
ec.t.d., descendant of ectodermal teloblast
ec.t.0.d.,-ec.t.6.d., descendants of median and lateral ectodermal teloblasts
m., primary mesoderm
m.t., mesodermal teloblast
m.t.d., descendant of mesodermal teloblast
m.t.1.,-m.t.4., the four mesodermal teloblasts of each side
pr., proctodaeum
t.m., telson mesoderm
y.g., yolk granule


50
m.
pr.
m
en.


51
m.t.
y.g.
pr.
m.t.
c.g.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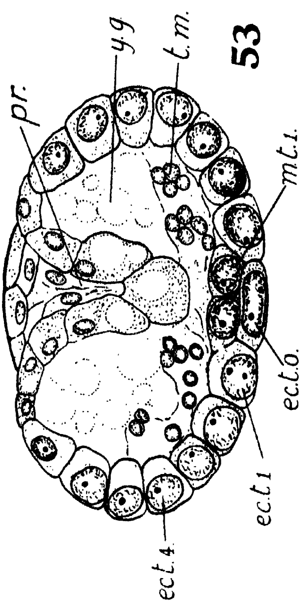
m.t.
m.t.d.
pr.
c.g
en.
ec.t.
ec.t.d.


53
pr.
y.g
t.m.
m.t.1.
ec.t.o.
ec.t.1
ec.t.4

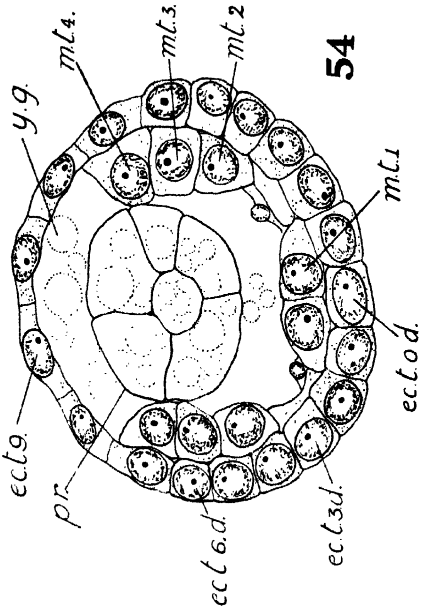

54
y.g.
m.t.4.
m.t.3
m.t.2
m.t.1
ec.t.o.d.
ec.t.3.d.
ec.t.6.d.
ec.t.9.
pr.

PLATE IX

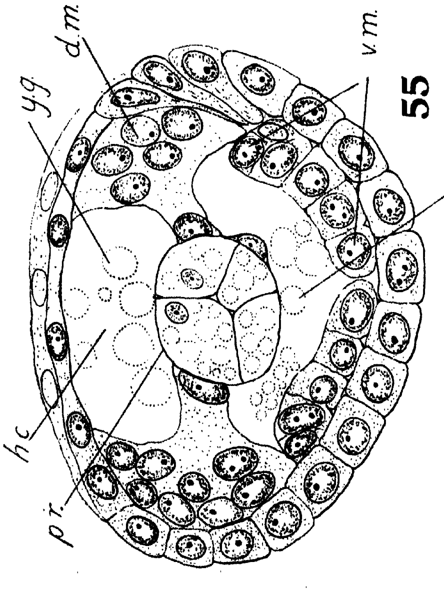
Fig. 55.—Transverse section of the caudal papilla of a 15-week embryo. The section is somewhat further forward than those in figs. 53 and 54. The dorsal and ventral mesoderm are differentiated, and the dorsal mesoderm has commenced its upward growth to form the lateral walls of the dorsal vessel.

Fig. 56.—Transverse section through the third abdominal segment of a 22-week embryo. The walls of the dorsal vessel are now formed, and the pericardial cavity is established by the shrinking away of the mesoderm from the dorso-lateral ectoderm. The floor of the dorsal vessel has been formed by the mesoderm growing over the yolk-sac. Yolk-granules and cells that have spread backward from the naupliar mesoderm are present in the cavity of the dorsal vessel and at the sides of the yolk-sac.

Fig. 57.—Transverse section through the maxillulary somite of a newly hatched specimen, showing the large anterior cavity of the heart roofed over by the dorsal organ.

Fig. 58.—Transverse section through the fourth thoracic somite of a newly hatched specimen, showing the thickened wall of the heart.

*a.l.*1., primary anterior lobe of liver
d.l.m., dorsal longitudinal muscles
d.m., dorsal mesoderm
d.o., dorsal organ
en., endodermal cell
g., genital rudiment
h.c., cardiac cavity or cavity of dorsal vessel
h.f., floor of cardiac cavity
*mx.*1.*c.*, coelomic cavity of maxillulary segment
n.m., naupliar mesoderm
pc.c., pericardial cavity
pc.f., pericardial floor
p.l., posterior lobe of liver
v.m., ventral mesoderm
v.l.m., ventral longitudinal muscles
y.g., yolk-granules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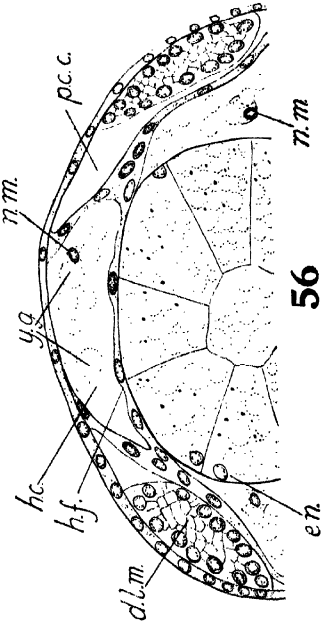
h.c
p.r.
y.g.
d.m.
v.m.
y.g.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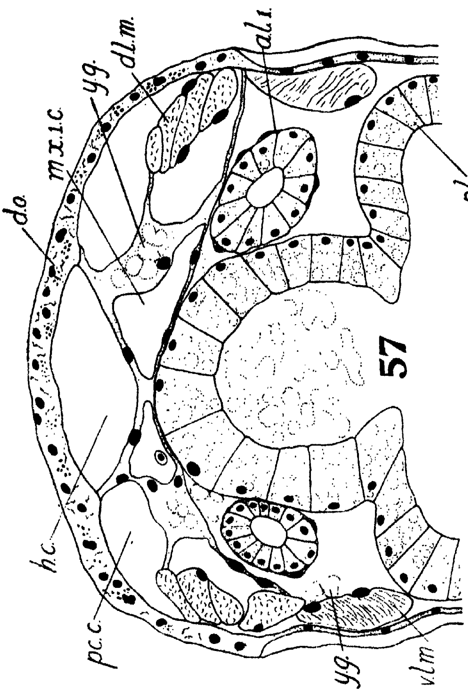
h.c.
h.f.
d.l.m.
y.g.
n.m.
p.c.c.
n.m.
e.n.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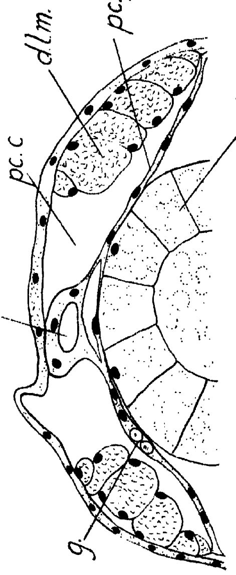
d.o.
mx.1.c.
y.g.
d.l.m.
al.1.
pl.
h.c.
p.c.c.
y.g.
v.l.m.


58

d.l.m.
pc.f.
pc.c.
e.n.
h.c.
g.

PLATE X

Fig. 59.—Transverse section through the fifth abdominal somite of a newly hatched specimen. The section passes immediately in front of the hind-gut, and shows the endodermal cells of the yolk-sac forming the epithelium of the mid-gut, which at this point is completely invested by mesoderm.

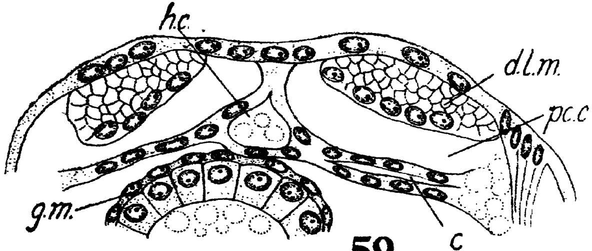
Fig. 60.—Transverse section in front of the stomodaeum of a newly hatched specimen. The anterior aorta and lateral cephalic arteries have appeared in the naupliar mesoderm between the yolk-sac and brain.

Fig. 61.—Sagittal section through an embryo at the stage shown in fig. 23. The stomodaeal invagination reaches almost to the proctodaeum.

Fig. 62.—Sagittal section through an embryo slightly older than that of fig. 61.

Fig. 63.—Sagittal section through an embryo about as old as that shown in fig. 27. The labrum is growing over the mouth and the posterior end of the stomodaeum is being pulled forward.

a.a., anterior aorta
b.c., blood corpuscle
br., brain
c., coelomic cavity
c.p., caudal papilla
cu., cuticle
d.l.m., dorsal longitudinal muscles
ec.t.d., descendant of ectodermal teloblast
en., endodermal cell
g.m., mesodermal investment of gut
h.c., cardiac cavity
lb., labrum
lb.m., labral mesoderm
l.c.a., lateral cephalic artery
m.t., mesodermal teloblast
n.m., naupliar mesoderm
pr., proctodaeum
st., stomodaeum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pc.c
g.m.
c

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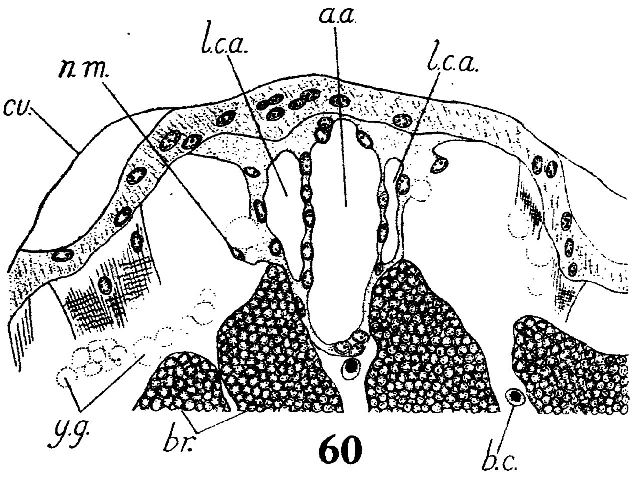
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l.c.a.
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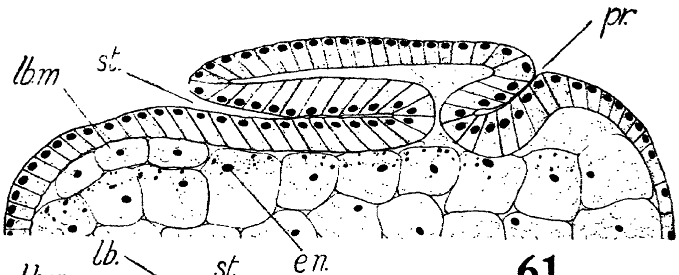
cu.
y.g.
br.
b.c.

60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st.
e.n.

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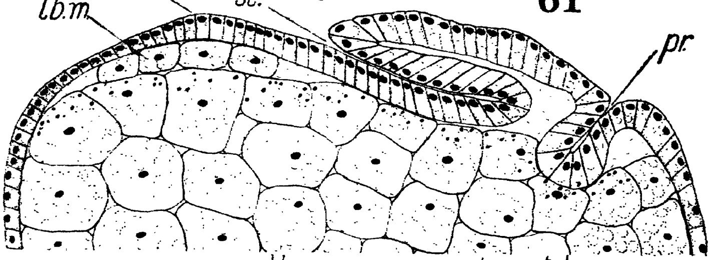
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lb.
st.
pr.

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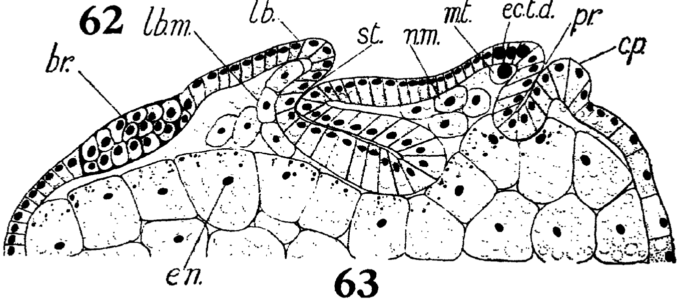

br.
lb.m.
lb.
st.
nm.
mt.
ec.t.d.
pr.
cp.
e.n.

63

PLATE XI

Fig. 64.—Sagittal section through a 15-week embryo. The caudal flexure occurs just behind the maxillulary somite. The caudal papilla is well developed, and the anal aperture occupies a postero-dorsal position. The end of the stomodaeal invagination now underlies the brain. The yolk-granules in the naupliar mesoderm are being slowly absorbed. The posterior end of the yolk-sac extends into the caudal papilla.

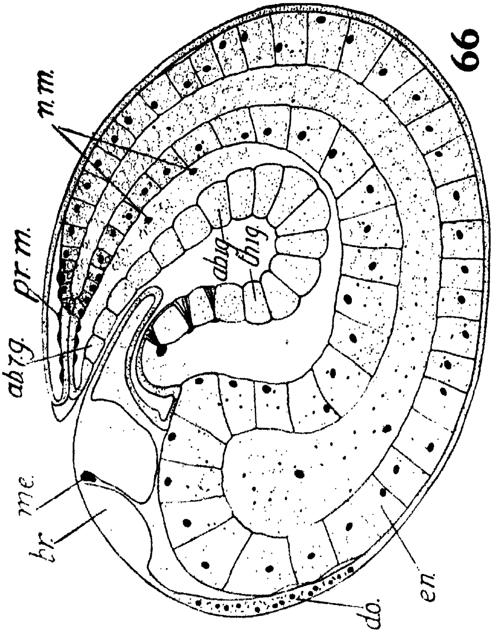
Fig. 65.—An older stage than that of fig. 64. The stomodaeum is now much shorter, the caudal flexure has shifted backwards to the first thoracic somite, and the yolk-sac has become longer. Cells from the naupliar mesoderm have moved backward into the post-mandibular region.

Fig. 66.—Sagittal section through an embryo about 25 weeks old. All somites are now formed. The nerve cord has a seventh abdominal ganglion. Cells which have shifted backward from the naupliar mesoderm are seen below the yolk-sac in the abdomen. Chromatin granules are still present among the yolk-globules of the endoderm.

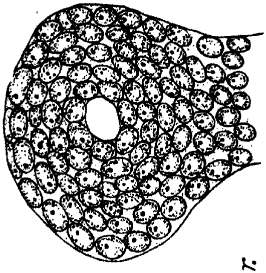
Fig. 67.—Transverse section through the median eye at its first appearance, showing its origin from paired rudiments. Pigment is being deposited in two cells, one on each side of the mid-line.

Fig. 68.—Surface view of the concentric rows of cells in the protocerebrum of an embryo at the stage shown in fig. 29.

an., anus
ab.1.g., first abdominal ganglion
ab.7.g., seventh abdominal ganglion
br., brain
c.p., caudal papilla
d.o., dorsal organ
en., endodermal cell
lb., labrum
lb.m., labral mesoderm
md.g., mandibular ganglion
m.e., median eye
n.m., naupliar mesoderm
pr.m., mesodermal investment of proctodaeum
s.t., stomodaeum
th.1.g., first thoracic ganglion
y.g., yolk-granule
y.s., yolk-sac


n.m.
pr.m.
ab.r.g.
ab.1.g.
th.1.g.
me.
br.
do.
en.

66



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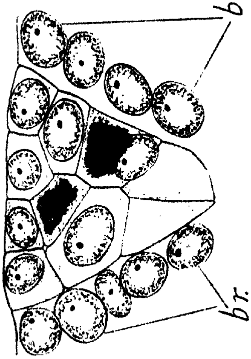
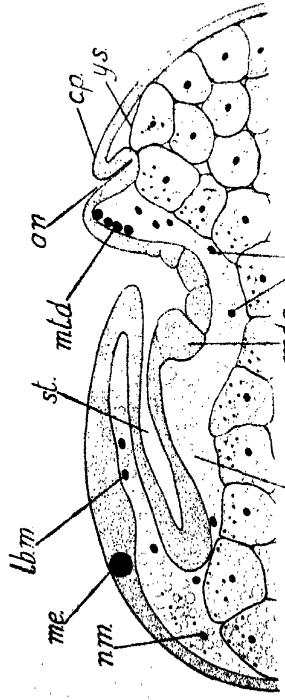

br.
br.

67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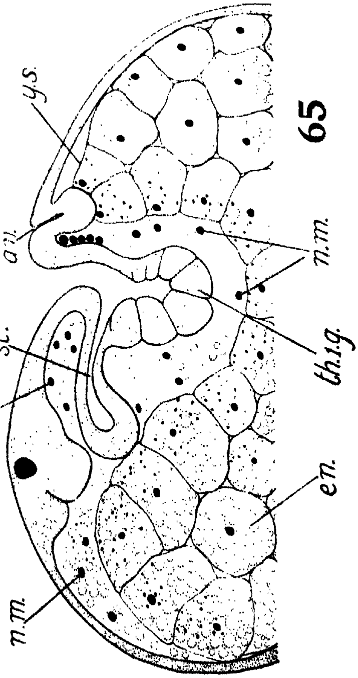
y.s.
an
mt.d.
n.m.
md.g.
st.
y.g.
lb.m.
me.
n.m.

64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st.
lb.m.
en.
n.m.

65

PLATE XII

Fig. 69.—Frontal section through the anterior end of an embryo at a late stage of embryonic life. The posterior liver lobes appear as outgrowths of the yolk-sac. They already extend backwards for a short distance, and are capped with mesoderm.

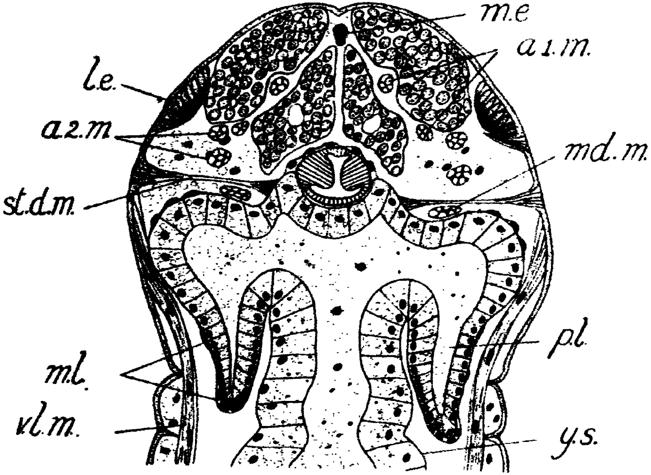
Fig. 70.—A *reconstruction of* the liver *of an* embryo about the same age as that shown in fig. 69. The posterior lobe is well developed. The primary anterior lobe has bent over, and is growing backward. The secondary anterior lobe is appearing at the bend in the primary lobe.

Fig. 71.—A reconstruction of the liver of a newly hatched specimen. The posterior lobe is now finger-like. The primary anterior lobe has increased in length, the secondary anterior lobe has bent over and is growing backward, and a third anterior lobe is forming at the bend in the secondary lobe.

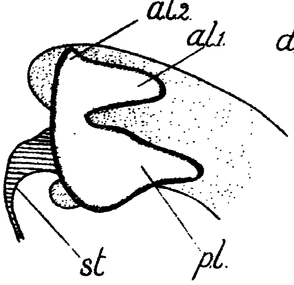
Fig. 72.—Transverse section through the sixth thoracic segment of a newly hatched specimen, showing the genital rudiment in the pericardial floor. The coelomic pouch has shrunken and disappeared.

Fig. 73.—Parasagittal section through the fifth thoracic segment of a newly hatched specimen, showing the length of the genital rudiment.

a.1.m., antennulary muscles
a.2.m., antennary muscles
a.l.1., primary anterior lobe of liver
a.l.2., secondary anterior lobe of liver
a.l.3., tertiary anterior lobe of liver
d.l.m., dorsal longitudinal muscles
en., endodermal cell
g., genital rudiment
h.c., cardiac cavity
l.e., lateral eye
m.e., median eye
md.m., dorso-ventral mandibular muscle
m.l., mesodermal investment of liver
pc.c., pericardial cavity
pc.f., pericardial floor
p.l., posterior liver-lobe
st., stomodaeum
st.d.m., dilator muscle of stomodaeum
v.l.m., ventral longitudinal muscles
y.s., yolk-sac


m.e
a.1.m.
l.e.
a.2.m
md.m.
st.d.m.
p.l.
m.l.
v.l.m.
y.s.

69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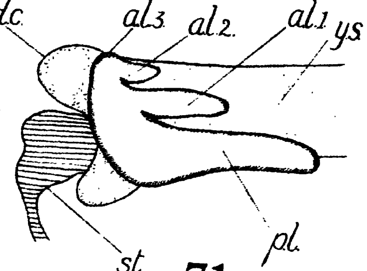
al.1
st
p.l.

70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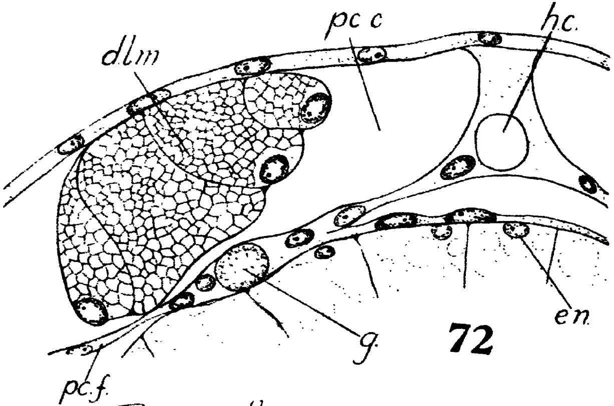
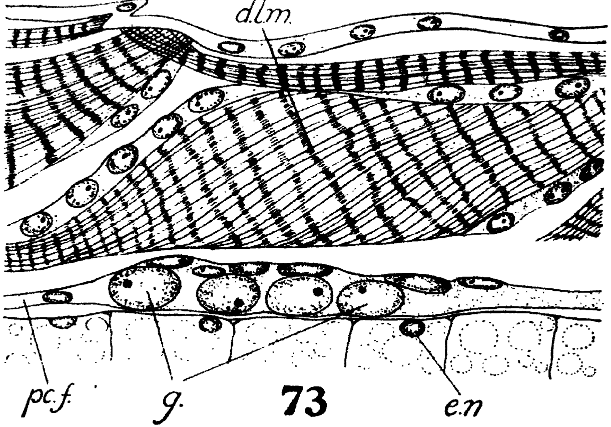
al.2.
al.1
y.s.
st.
p.l.

71


pc c
h.c.
d.l.m
g.
e.n.
pc.f.

72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pc.f.
g.
e.n

73

PLATE XIII

Fig. 74.—A sagittal section through the posterior end of the body of a 25-week embryo, showing the seventh abdominal ganglion below the junction of the yolk-sac with the proctodaeum.

Fig. 75.—A later stage than that of fig. 74, showing the sixth abdominal ganglion separated from the fifth. The seventh abdominal ganglion is being pulled into a position above the sixth.

Fig. 76.—An almost sagittal section through the end of the abdomen of a newly hatched specimen, showing the remnant of the seventh abdominal ganglion above the sixth, and separated from it by a slender intersegmental bar.

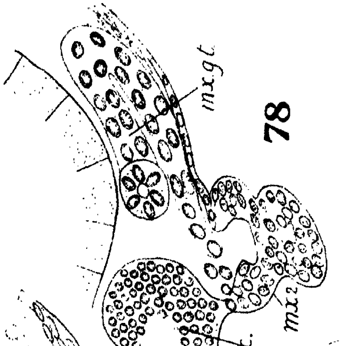
Fig. 77.—Transverse section through the base of the maxillary somite of a 17-week embryo, showing the mesodermal rudiment of the maxillary gland.

Fig. 78.—A slightly later stage than that of fig. 77. The mesodermal cells are becoming oriented transversely to form the tubule of the gland.

Fig. 79.—A sagittal section through the basal segment of the maxilla in a newly hatched specimen, showing the duct of the maxillary gland passing under the adductor muscle and opening by a pore on the posterior surface of the appendage.

Fig. 80.—Section through the lateral part of the maxillary gland of a newly hatched specimen, showing the well-developed tubule cut transversely in several places.

ab.5.g.-ab.7.g., fifth-seventh abdominal ganglia
i.b., intersegmental ectodermal bar
n.m., cells from the naupliar mesoderm, which have shifted backward into the abdominal region
mx.2., maxilla
mx.g., maxillary gland
mx.g.d., duct of maxillary gland
mx.g.p., external aperture of maxillary gland
mx.g.t., tubule of maxillary gland
mx.t.m., transverse adductor muscle in basal segment of maxilla
n.c., nerve cord
pr., proctodaeum
pr.m., mesodermal investment of proctodaeum
y.g., yolk-granules



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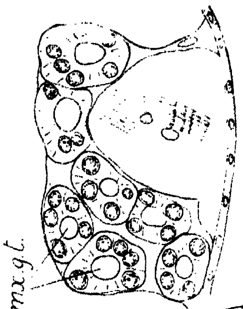

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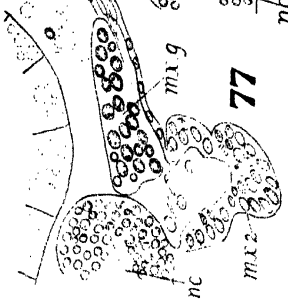

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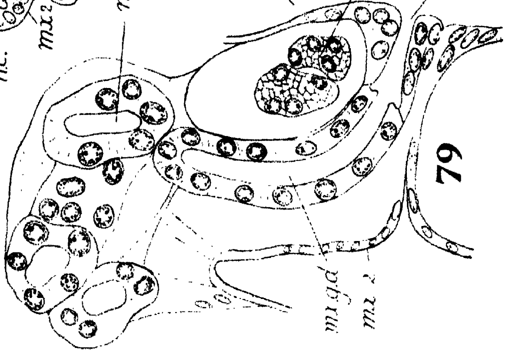

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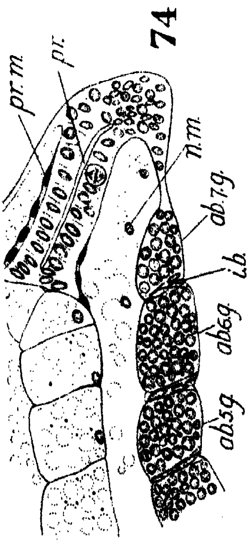

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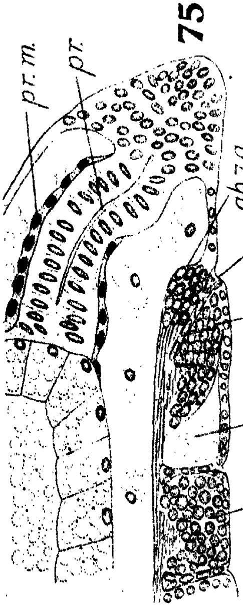

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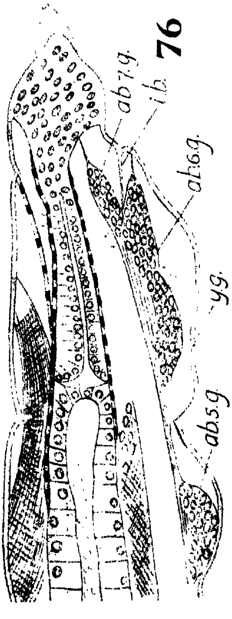

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PAP. & PROC. ROY. SOC. TASMANIA, 1936 (31ST MAY, 1937)

Australian Leaf-Hoppers (Jassoidea, Homoptera)
Part 4*
(Ledridae, Ulopidae, and Euscelidae, Paradorydiini)

By

J. W. EVANS, M.A., F.R.E.S.

PLATES XIV-XVI

(Read 12th October, 1936)

This paper is concerned with three groups of leaf-hoppers. These are not closely related to each other, but are considered together because of the striking similarity in appearance between certain representatives of each group. This resemblance may be due to the effect of identical environmental factors, to the possession, at least by two of the groups, of a similar inherent orthogenetic trend, or to chance resemblance furthered by parallel evolution.

Family LEDRIDAE

The Ledridae have representatives in Europe, Africa, Asia, and Australia. Although Walker (1851, 1858) described sixteen leaf-hoppers from Australia which he placed in the genus *Ledra* F., it has since been shown that this genus does not occur in the Australian region. The majority of Walker's species belong to another family, the Stenocotidae.

The Ledridae are characterized by the dorsal position of the ocelli, and the structure of the hind tibiae. These are invariably flattened and may be spineless or bear a few short spines on the outer edges. The Australian representatives can be divided into two sub-families, the Ledrinae and the Cephalelinae. Six genera belonging to the Ledrinae have previously been described from Australia. Three new ones are defined below.

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* Previous parts in this series of papers were not numbered, but were published in the following order:

Part 1: A Revision of the Eurymelini. Trans. Roy. Soc. S. Aust. 57, 1933.
Part 2: A Revision of the Ipoinae. Proc. Roy. Soc. S. Aust. 58, 1934.
Part 3: The Bythoscopidae of Australia. Papers & Proc. Roy. Soc. Tas. 1935

As an aid to the identification of the genera, figures are given of a representative of every genus. These render the provision of a key to the genera unnecessary. The Ledrinae differ from the Cephalelinae in their larger size, and in never having the lateral margins of the pronotum parallel to each other.

Sub-family *LEDRINAE*

The following genera and species of the Ledrinae have previously been described from Australia:

Genus **Ledropsis** White

Ann. & Mag. Nat. Hist. 1 (XIV) ; 425, 1844

In this genus there are four described species, *coccinea* Butler (1874), and *acuminata*, *crocina*, and *froggatti* Distant (1907). Plate XIV, fig. 1, represents the head and thorax of *Ledropsis crocina*. This species is pale-brown in colour, and the head and anterior half of the pronotum are at a lower level than the scutellum and the hind margin of the pronotum. The venation of the tegmina is recticulate.

Genus **Jukaruka** Distant

Ann. Soc. Ent. Belg. 51 : 190, 1907

The single species in this genus, *typica* Dist. (1907) (Plate XIV, fig. 2), is closely related to *Ledropsis*, differing principally in the shorter and more truncate head.

Genus **Porcorhinus** Goding

Proc. Linn. Soc. N.S.W. 28 ; 38, 1903

The single species in this genus, *mastersi*, Goding (Plate XIV, fig. 6), was originally described as a membracid, due to the development of lateral margins of the pronotum posteriorly. It is more closely related to *Ledropsis* spp. and *Jukaruka typica* than to species in other genera. *Gudwana* Distant (1907) is a synonym of *Porcorhinus*.

Genus **Ledromorpha** Stål

Ann. Soc. Ent. Fr. 4 (IV) ; 68, 1864

The following species belonging to this genus have been described: *vaginata* Stål (1864), *planirostris* Donovan (1805), *Ledra caudata* Walk. and *Ledra valida* Walker. Both Walker's species are synonymous with *planirostris* Don. *L. planirostris* (Plate XIV, fig. 4) is the largest member of the family occurring in Australia. The female measures 30 mm. from the apex of the head to the tip of the ovipositor.

Genus **Petalocephala** Stål

Öfv. Vet.-Ak. Förh. 22; 158, 1865

The Australian species, *Ledra brevifrons* Walker (1851), considered by Distant (1907) as belonging to this genus, is unknown to me. Among the generic characters given by Stål are: small eyes; ocelli situated at the foot of the vertex nearer to each other than the eyes; thorax hexagonal, very slightly or not at all narrowed anteriorly. Tegmina sub-coriaceous, transparent, densely punctate, veins branching irregularly against the apex, not quite distinct. (Mr. China informs me that the type specimen of *Ledra brevifrons* is not a true *Petalocephala*, but probably represents a new genus related to *Rubria*, but differing from it in that the head is much shorter than wide across the eyes, and the thorax is shorter and more declivous.)

Genus **Rubria** Stål

Öfv. Vet.-Ak. Förh. 22, 1865

This genus differs from *Petalocephala*, in that the ocelli are situated behind the middle of the disk of the vertex, the distance between them being equal to or less than their distance from the eyes. Tegmina with five apical cells. Two species are known from Australia, *sanguinea* Stål and *carnosa* Stål (Plate XIV, figs. 3a, 3b, 10). These are probably the commonest members of the family.

Kirkaldy (1906) described seven species of leaf-hoppers, which he placed in the genus *Rhotidus* Walk. (Euscelidae). An examination of the figures accompanying the descriptions suggests that they may all belong to *Rubria* Stål.

Platyledra, gen. nov.

The head is spatulate, narrowing apically to a point; dorsally it is convex, ventrally concave. The lateral sutures of the frons are deep, the lorae depressed, and the clypeus small and pear-shaped. The maxillary plates are narrow. The ocelli are on the dorsal surface, well in front of the eyes, and are closer to the eyes on each side than to each other. There is a well-defined dorsal median longitudinal keel that extends on to the pronotum, and the head, which has in addition irregular small ridges on its dorsal surface, is wider medianly than across the eyes. The pronotum is collar-like and more or less rectangular, the tegmina are coriaceous, the veins raised in relief, and the venation reticulate. The hind tibiae are flattened and spineless, each of the outer edges bearing a fringe of short hairs only. The ovipositor, which extends well beyond the apex of the folded tegmina, is concave ventrally and tectiform dorsally.

Platyledra hirsuta, sp. nov. (Genotype)

(Plate XIV, figs. 5a, 5b)

Length, 17 mm. (from the apex of the head to the tip of the folded tegmina). *Head*, ventral surface, dull yellow, clypeus red, lateral frontal sutures brown. Frons, antennal pits, and clypeus sparsely covered with short white hairs. Dorsal surface of head, pronotum, and scutellum pale brown with dark brown markings. *Tegmen*, grey, veins dark grey. *Thorax* and *abdomen*, ventral surface, and *legs*, pale brown with dark brown markings.

Type ♀, from Ooldea, South Australia (coll. A. M. Lea), in the collection of the South Australian Museum.

Ledrella, gen. nov.

The frons is swollen posteriorly, the antennal ledges distinct and parallel to the hind margin of the ventral surface of the head, the antennal pits shallow, and the maxillary plates narrow. The ventral surface of the head is separated from the dorsal surface by a sharp ridge. Dorsally the head is slightly rounded anteriorly, though not produced, and the ocelli occur just in front of the eyes. The anterior margin of the pronotum is parallel with the dorsal anterior margin of the head, and is narrow laterally and somewhat declivous. The tegmina are evenly rounded apically, and the venation is not reticulate. The hind tibiae are flattened, the outer edges bearing two rows of mobile spines mounted on slightly protuberant bases.

Ledrella brunnea, sp. nov. (Genotype)

(Plate XIV, figs. 9a-9c)

Length, 5 mm. *Head*, *pronotum*, and *scutellum*, pale brown. Head with the ocelli closer to the eyes on each side than to each other. *Tegmen*, transparent; veins brown with white bars. *Thorax* and *abdomen*, ventral surface pale brown with dark brown markings. *Male genitalia*, as in Plate XIV, fig. 9c. The long narrow process, parallel to the aedeagus, is attached to the pygophore, and is not part of the aedeagus, as might appear from the figure.

Type ♂, from Kiata, Victoria (coll. F. E. Wilson), in the collection of the Australian Museum, Sydney.

Ledraprora, gen. nov.

The head is convex ventrally, and the frons is produced anteriorly into a long narrow process. The maxillary plates are wide and the frons narrow. The ocelli are on the dorsal surface of the head, well in front of the eyes, and face outwards. The pronotum narrows laterally, but the propleurae are sufficiently wide to separate the head from the bases of the tegmina. The tegmina are evenly rounded apically, and the venation is distinct and not reticulate. The hind tibiae, which are convex on their internal surfaces, are flattened exteriorly, and bear a row of short mobile spines, mounted on slightly protuberant bases, along both the outer edges. In the female the sheath of the ovipositor extends well beyond the apices of the tegmina.

Ledraprora insularis, sp. nov. (Genotype)

(Plate XIV, figs. 7a-7d)

Length, 9·5 mm. *Head*, length of dorsal surface 3·3 mm., width across the eyes 2 mm., brown. The anterior prolongation of the frons has two lateral swellings, is rounded apically, and is keel-shaped both dorsally and ventrally. The ocelli are nearer to each other than to the eyes on each side. *Pronotum* and *scutellum*, pale brown. *Tegmen*, pale hyaline-brown, veins marked with irregular brown and white markings. *Thorax* and *abdomen*, ventral surface, and *legs*, pale brown.

Type ♀, from Kangaroo Island (coll. A. M. Lea), in the collection of the South Australian Museum.

Ledraprora victoriensis, sp. nov.

(Plate XIV, fig. 8)

Length, 10 mm. *Head*, dark brown, the anterior prolongation of the frons more or less circular in section, without lateral swellings. Ocelli closer to the eyes on each side than to each other. *Pronotum* wider laterally than with the genotype, pale brown with dark brown markings. *Scutellum*, pale brown. *Thorax* and *abdomen*, ventral surface pale brown with dark brown markings.

Type ♂, from Kiata, Victoria (coll. F. E. Wilson), in the collection of the Australian Museum, Sydney.

Sub-family *CEPHALELINAE*

The Cephalelinae comprise a group of small narrow leaf-hoppers that have been recorded from South Africa, Australia, and New Zealand. The following characters will enable their separation from the Parydorydiini, which they superficially resemble:

> The head is produced anteriorly; ocelli, if present, are on the dorsal surface of the head, in front of and between the eyes, frequently they are functionless or even absent. The genae, or that part of the head that lies between the eyes and the frons, may be separated from the maxillary plates by an indistinct transverse suture. The pronotum is collar-like and parallel-sided.

> The head, thorax, and tegmina, the lastnamed either proximally only or entirely, are punctate. The tegmina narrow apically, and the venation may be distinct or obscure. Hind wings are absent. The femora are strongly incrassate, and the tibiae distinctly flattened or foliate. The hind tibiae are short and not adapted for jumping. They are feebly spinose along the outer edge.

The available species are placed in four genera, of which two are new.

This group of leaf-hoppers is considered as a sub-family of the Ledridae because of the characters supplied by the elongate head, the dorsal position of the ocelli, and the flattened and feebly spinose hind tibiae. Their nomenclature has been in a state of confusion, partly because of the resemblance of certain species to *Paradorydium* spp., and also because of the uncertainty that existed at one time as to the genotype of *Dorydium* Burm. In addition to the species listed below it is possible that *Dorydium foveolatum* Signoret belongs to the Cephalelinae.

Genus **Cephalelus** Percheron

Mag. Zool. II, 1832

Dorydium Burm., *Hand. Ent.* II, 106, 1835

Genotype *C. infumatus* Perch.

Two species have been described from Australia that belong to this genus, *brunneus* Waterhouse and *marginatus* Waterhouse (1839). The entire dorsal surface of the head is punctate, and the head, which is considerably produced anteriorly, is convex dorsally and evenly concave ventrally. The lateral frontal sutures in the adults terminate at the antennal pits, which are deep, and form a notch in the side of the head, and the eyes are small. The anterior margin of the prothorax is almost straight. The tegmina are long and narrow, coriaceous and sharply pointed apically, and the venation is obscure. The fore and middle tibiae are flattened externally and narrow distally. The hind tibiae are slightly longer, flattened and parallel-sided. Plate XV, fig. 14, represents *Cephalelus brunneus.*

Genus **Notocephalius** Jacobi

Faun. S.W. Aust. Michaelsen u. Hartmeyer ii; 329, 1909

This genus is only known to me from the original description. The figure of the genotype, *Notocephalius hartmeyeri* Jac., that accompanies the description makes it clear that this species is not congeneric with *Cephalelus brunneus.*

Procephaleus, gen. nov.

The head is long, slightly bulbous apically, and more or less circular in cross-section. The ocelli are rudimentary, and the eyes are not prominent. The lateral portions of the anterior margin of the pronotum are not straight, due to the backward prolongation of the eyes. The tegmina are coriaceous, and the venation is distinct. The tibiae resemble those of *Cephalelus* spp.

Procephaleus bulbosa, sp. nov. (Genotype)

(Plate XV, fig. 13)

Length, 8·2 mm. *Head*, width ·8 mm., length 3 mm., ventrally pale brown, dorsally pale brown with dark brown punctures; eyes chocolate-brown. *Pronotum*, concolorous with the head. *Scutellum*, pale brown with a few scattered punctures. *Thorax* and *abdomen*, ventral surface, and *legs*, pale brown.

Type ♀, from Carlisle, Western Australia (coll. D. C. Swan), in the collection of the Australian Museum, Sydney.

Anacephaleus, gen. nov.

The head is produced anteriorly, but is shorter and wider than in the previous two genera, being more or less triangular in shape, flat or slightly rounded dorsally and convex ventrally. The antennal pits are deep. Ocelli may be present or absent and the eyes slightly or very prominent. The prothorax is emarginate laterally. The tegmina are transparent, hyaline or coriaceous and thickened along the anterior costal margin, and the venation is distinct. In addition to the new species described below, *Dorycephalus subreticulatus* Kirk., *D. ianthe* Kirk., and *D. trilineatus* Kirk. (1906) belong to this genus. The figure given by Jacobi of *Paradorydium michaelseni* Jac. (1909) suggests that this species also belongs to the present genus.

Anacephaleus minutus, sp. nov. (Genotype)

(Plate XV, figs. 7a, 7b; Plate XVI, fig. 1)

Length, 3·5 mm. *Head*, width ·8 mm., length of dorsal surface 1 mm., punctate, brown with dark brown markings; labium long, reaching to beyond the bases of the hind legs; clypeus small, pear-shaped; genae separated from the maxillary plates by a transverse suture. Frons parallel-sided, the lateral borders terminating at the antennal pits, which are deep; vertex with a slight median longitudinal ridge; ocelli present, closer to each other than to the eyes on each side. *Pronotum* and *scutellum*, punctate, brown with dark brown markings. *Tegmen*, transparent, punctate basally and along the veins; venation distinct. *Thorax* and *abdomen*, ventral surface, and *legs*, brown.

Type ♀, from Perth, Western Australia (coll. D. C. Swan), in the collection of the Australian Museum, Sydney.

Note.—This species has also been taken on Mount Wellington, Hobart, Tasmania.

Anacephaleus ulopae, sp. nov.

(Plate XV, fig. 9)

Length, 5 mm. *Head,* width across the eyes 1 mm., length 1·2 mm., pale brownish-yellow with brown and white markings; eyes dark brown, prominent; labium reaching to between the middle pair of legs. Ventral surface of head similar to that of the genotype, dorsal surface with rudimentary ocelli and two crescentic prominences between the ocelli and the eyes on each side, and with a median longitudinal ridge. The apex of the head is slightly tilted upwards. *Tegmen,* with reticulate venation; veins distinct, in relief, and the whole surface of the tegmen punctate. The costal margin of the tegmen is rounded, the anal border straight, and the tegmen is pointed apically.

Type ♀, from Adelaide, South Australia (coll. A. M. Lea), in the collection of the South Australian Museum.

Note.—This species bears a close superficial resemblance to *Austrolopa* spp.

Anacephaleus carribensis, sp. nov.

(Plate XV, figs. 8a-8c)

Length, 4 mm. *Head,* width ·7 mm., length 1 mm., pale reddish-brown with dark brown and whitish markings; labium reaching to between the middle pair of legs; clypeus swollen, almost circular, vertex without a median ridge, ocelli rudimentary, closer to each other than to the eyes on each side; eyes prominent. *Pronotum* and *scutellum,* brown, punctate. *Tegmen,* hyaline-brown, punctate basally; veins brown, distinct.

Type ♀, from Carribie, York Peninsula, South Australia (coll. N. B. Tindale), in the collection of the South Australian Museum.

Anacephaleus simplex, sp. nov.

(Plate XV, figs. 10a, 10b)

Length, 7 mm. *Head,* width 1 mm., length 2 mm., pale brown, spatulate, evenly convex ventrally, dorsally with a median longitudinal ridge; ocelli absent; eyes protruding slightly laterally. *Tegmen,* narrow apically, veins brown, distinct, punctate proximally, transparent distally; venation not reticulate.

Type ♀, from Mordialloc, Victoria, in the collection of the National Museum, Melbourne.

Anacephaleus punctatus, sp. nov.

(Plate XV, fig. 12)

Length, 10 mm. *Head*, length 4 mm., slightly concave ventrally; frons ventrally, clypeus, and eyes, chocolate-brown; head dorsally dull brown with dark brown punctures, and with a low but distinct median ridge. Head laterally with a V-shaped indentation adjacent to the antennae; ocelli distinct, white. *Tegmen*, brown, punctate, venation distinct.

Type ♀, from Kiata, Victoria (coll. F. E. Wilson), in the collection of the Australian Museum, Sydney.

Family EUSCELIDAE

Sub-family *EUPELICINAE*

Tribe *Paradorydiini*

This group of insects is considered here on account of the close resemblance borne by some of its representatives to certain of the Cephalelinae. Among the common characteristics are, in addition to similarities of size, shape, and coloration, the narrow elongate head, absence of hind wings in *Paradorydium* spp., and the punctate head, thorax, and tegmina. They differ in the position of the ocelli, which in the Paradorydiini are situated on the lateral margins of the head, just in front of the eyes, in the venation of the tegmina, and in the structure of the hind tibiae, which have an armature of stout bristle-like spines. In addition the pronotum is never collar-like, and the anterior margin of the pronotum never parallel to the hind margin. The Paradorydiini, which are a tribe of the Euscelidae, are of world-wide distribution. Two genera occur in Australia. These are *Paradorydium* Kirkaldy and *Deltodorydium* Kirkaldy.

Genus **Deltodorydium** Kirkaldy

Bull. Hawaii Sug. Ass. Ent. 3; 73, 1907

This genus (considered a sub-genus by Kirkaldy) is possibly closely related to *Gealeka* Naudé (1926). The dorsal surface of the head, which is angularly produced, is more or less triangular in shape and flat. The ventral surface is slightly rounded, with the maxillary plates wide, the lateral margins of the clypeus parallel to each other, and the antennal pits shallow. The ocelli are situated on the lateral margins of the head, just in front of the eyes, which are not prominent. The head, pronotum, and scutellum are dotted with shallow punctures. The tegmina are punctate, except at the apices, and the venation is distinct. Hind-wings are present and the hind tibiae bear an armature of strong spines.

Two species belonging to this genus have previously been described from Australia. These are *D. ovidici* Kirk. and *D. brighami* Kirk. (1907). Figure 4, Plate B, which represents the head and thorax of the genotype, *D. brighami*, was drawn from the paratype.

Deltodorydium cooki, sp. nov.

(Plate XV, figs. 1a, 1b; Plate XVI, fig. 2)

General coloration, pale brown. *Length*, 3 mm. *Head*, width 1 mm., pale brown, punctate. *Pronotum* and *scutellum*, pale brown, punctate. *Tegmen*, punctate, excepting apically, venation obscure. Hind tibiae considerably larger than the tibiae of the front and middle pair of legs.

Type ♂, from Adelaide, South Australia (coll. F. Cook), in the collection of the Australian Museum, Sydney.

Deltodorydium viridis, sp. nov.

(Plate XV, figs. 3a, 3b)

Length, 3-3·5 mm., general coloration pale green. *Head*, width 1 mm., punctate; head shorter than with *D. leai*, and without a longitudinal ridge on the vertex ventrally; eyes dark green. *Pronotum*, with the posterior two-thirds a darker green than the anterior third, and wider laterally than in *D. leai*. *Tegmen*, greenish, venation distinct. *Thorax* and *abdomen*, ventral surface, and *legs*, pale green.

Type ♂, from Cannington, Western Australia (coll. M. Solomon on *Melaleuca* sp.), in the collection of the Australian Museum, Sydney.

Note.—Figures are given of two specimens of this species, in order to show the range of variation in the shape of the head.

Deltodorydium leai, sp. nov.

(Plate XV, figs. 2a, 2b)

Length, 3·5 mm., general coloration pale yellowish-brown. *Head*, width 1 mm.; clypeus extending beyond the maxillary plates, lorae not reaching to the anterior margin of the head; vertex with a short, sharp, median, longitudinal ridge extending on to the crown of the head, and from thence on to the pronotum; eyes dark brown. *Tegmen*, punctate, venation distinct.

Type ♂, from Mittagong, New South Wales (coll. A. M. Lea), in the collection of the South Australian Museum.

Genus **Paradorydium** Kirkaldy.

Entomologist 34: 339, 1901

Genotype, *Paradorydium lanceolatum* (Burm.)

The head is punctate and produced, the apex slightly tilted upwards and flattened dorsally. The ventral surface of the head has a median keel, and the dorsal surface, except apically, is rounded, with or without a median carina. The clypeus is more or less parallel-sided, the maxillary plates wide, and the antennal pits shallow. The ocelli are laterally placed just in front of the eyes. The anterior margin of the pronotum is rounded, the hind border almost straight, and the propleurae wide. The tegmina, which narrow apically, are punctate along the veins, and the venation is distinct. Hind-wings are absent. The hind tibiae have an armature of strong spines similar to those of *Deltodorydium* spp. Two Australian species belonging to this genus have previously been described. These are *Paradorydium menalus* Kirk. and *P. pseudolyricen* Kirk. (1906). The type locality of *menalus* Kirk. is in Northern Queensland. Specimens collected in Victoria (Kiata) and Tasmania (Hobart) so closely resemble this species as not to merit specific differentiation. Plate XV, fig. 6a, represents *P. menalus* Kirk., and fig. 6b the aedeagus of the male. The male genitalia are so similar in general structure to those of *Deltodorydium* spp. as to leave no doubt as to the close relationship existing between the two genera.

Paradorydium casuarinae, sp. nov.

(Plate XV, figs. 5a, 5b)

Length, 6·5 mm. *Head*, width 1 mm., length 2·5 mm., equal in length to the tegmina; pale straminaceous with pale brown punctures, laterally carinate for the entire length of the head. The median dorsal carina does not extend to the apex of the head, which is spatulate; a median ventral carina is also present. *Pronotum*, concolorous with the head, laterally carinate. *Scutellum* with two dark brown spots. *Tegmen* opaque, punctate, venation distinct.

Type ♀, from Canberra, F.C.T. (coll. J.W.E. on *Casuarina* sp.), in the collection of the C.S.I.R. Division of Entomology at Canberra.

Family ULOPIDAE

Austrolopa, gen. nov.

The head ventrally is transversely convex, with a median longitudinal ridge on the vertex; on either side of this ridge is a transverse depression. The frons is very large and flat anteriorly; it projects as a ledge above the clypeus, and its hind margin, which is distinct, lies well away from the hind border of the head; the clypeus is small, and narrows anteriorly. The lorae, which are bounded dorsally by the suture that divides the genae from the maxillary plates, lie for their entire length against the frons, and do not reach as far as the clypeus. The labium reaches as far as the middle pair of legs. The vertex is spatulate, and the crown, dorsally between the eyes, very broad. The eyes are prominent, and ocelli are present. The pronotum is shorter than the crown of the head, and the propleurae extend widely laterally. The scutellum is wide and short.

The tegmina, which are thickened along the anterior costal margin, are short and broad, and narrow apically. The venation is distinct. Hind-wings are absent, and the head, thorax, and tegmina are punctate. The tibiae of all three pairs of legs are quadrilateral in section, and are armed with minute spines.

The two species described below are the first representatives of this family to be recorded from Australia.

Austrolopa brunensis, sp. nov. (Genotype)

(Plate XV, figs. 16a-c)

Length, 4 mm. *Head*, width 1 mm., pale brown, the antennal flagellae dark brown, eyes brownish-grey; crown of head, from above, dark brown with whitish markings. Hind margin of frons distinct and entire; head, from above, not on a plane with the pronotum, but tilted dorsally. *Pronotum*, grey with brown markings. *Scutellum*, dark brown with whitish markings. *Tegmen* marked with an irregular pattern of brown and white. *Thorax* and *abdomen*, ventral surface, pale brownish-yellow. *Legs*, pale brownish-yellow with dark brown markings. Male genitalia as in Plate XV, figs. 16a-c.

Type ♂, from Bruni Island, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

Note.—This species has also been taken at Margate, Tasmania, and Brisbane, Queensland.

Austrolopa kingensis, sp. nov.

(Plate XV, figs. 15a-d.; Plate XVI, fig. 3)

Length, 4 mm. *Head*, width 1 mm., ventral surface pale brownish-yellow with irregular dark brown markings; hind margin of frons not complete, the lateral sutures being separated by the median ridge on the vertex, which in this species extends on to the frons. Crown of head on the same plane as the pronotum. *Pronotum* and *scutellum*, pale brownish-yellow, with or without dark brown markings. *Thorax* and *abdomen*, ventral surface, and *legs*, pale brownish-yellow. Male genitalia, aedeagus as in Plate XV, fig. 15d.

Type ♂, from King Island, Tasmania, in the collection of the Australian Museum, Sydney.

Note.—This species has also been taken at Warburton Victoria.

Discussion

Myers (1923), who considered *Cephalelus* and *Paradorydium* to be both genera of the Cephalelinae, was struck, as are all who have seen these insects, by the extraordinary resemblance they bear to plant spines and seeds. Little is known of their life-history and habits, since they are usually only collected by sweeping. *Paradorydium westwoodi* F. B. White has been collected on rushes in New Zealand; *Cephalelus infumatus* Perch on the rush *Dovea tectorum* in Africa, and *C. hudsoni* Myers and *C. leptocarpi* Myers on the jointed rush *Leptocarpus simplex* in New Zealand. The only host records of Australian species available to me are of *Deltodorydium viridis* on *Melaleuca* sp.; *D. cooki* on the introduced *Echium plantagineum*; *Paradorydium menalus* on grass; *P. casuarinae* on *Casuarina* sp., and *Austrolopa* spp. on grass tussocks. All the species of *Dorydium* described by Naudé (1926) (presumably actually *Paradorydium* spp.) are recorded as being taken by grass-sweeping.

Whilst the short-headed species of the Paradorydiinae are winged, and may occur on shrubs, the fact that all the Cephalelinae and the genera *Austrolopa* and *Paradorydium* have no wings, or wings so ill-developed as to be functionless, suggests that this character is one that is associated with environmental factors. Many other grass-feeding Homoptera (Delphacids and various Jassoid genera belonging to the Euscelidae) lack wings, and may also have reduced tegmina.

The character of a produced head is also one that occurs in many groups of the Homoptera, as, for instance, with the Cercopidae (*Philagra*), Fulgoridae, Dictyophoridae, and Delphacidae, in addition to several Jassoid genera. The dorsal surface of such elongate heads may consist entirely of the vertex, or of both the vertex and part of the frons. The epicranial sutures, which may be indistinct in adult insects, can usually be distinguished in the nymphs.

Several characters common to *Anacephaleus* and *Austrolopa* suggest that these two genera may be fairly closely related to each other. Amongst those appertaining to the head are the presence of sub-genal sutures; the possession of mandibles which narrow at their proximal ends, and appear to consist of three parts; and of maxillae which are set far back in the head, and are attached to the maxillary apodemes by struts, that arise from the middle of the thickened part of the maxilla (not the end, as in *D. cooki*). With both the clypeus narrows apically. Other common characters are dorsal ocelli, wide sub-genital plates, and hind tibiae with only a few small spines. These characters, combined with others of a more secondary nature, such as lack of hind wings, pronota of similar shape, and similar coloration and general appearance, suggest that species in both genera are not far removed from the stem whence have developed the Ledridae and Ulopidae as distinct families.

I am indebted to Mr. W. E. China, of the British Museum, for assistance in this study.

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EXPLANATION OF PLATES

PLATE XIV

Fig. 1.—*Ledropsis crocina*, head and thorax, dorsal aspect

Fig. 2.—*Jukuruka typica*, head and thorax, dorsal aspect.

Fig. 3a.—*Rubria sanguinea*, head and thorax, dorsal aspect.

Fig. 3b.—*Rubria sanguinea*, head of nymph.

Fig. 4.—*Ledromorpha planirostris*, head, ventral aspect.

Fig. 5a.—*Platyledra hirsuta*, head, ventral aspect.

Fig. 5b.—*Platyledra hirsuta*, tegmen.

Fig. 6.—*Porcorhinus mastersi*, head and thorax in profile.

Fig. 7a.—*Ledraprora insularis*, head. ventral aspect.

Fig. 7b.—*Ledraprora insularis*.

Fig. 7c.—*Ledraprora insularis*, tegmen.

Fig. 7d.—*Ledraprora insularis*, hind tibia.

Fig. 8.—*Ledraprora victoriensis*, head and thorax, dorsal aspect.

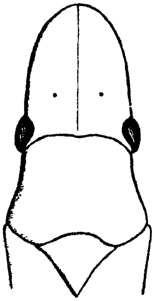
Fig. 9a.—*Ledrella brunnea*.

Fig. 9b.—*Ledrella brunnea*, head and thorax in profile.

Fig. 9c.—*Ledrella brunnea*, male genitalia.

Fig. 10.—*Rubria carnosa*, male genitalia.

PLATE XIV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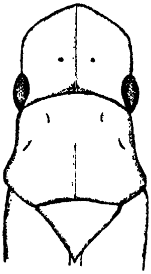
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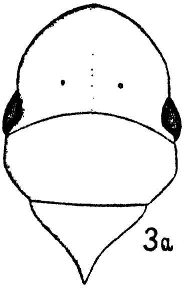
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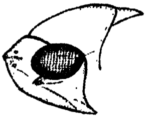
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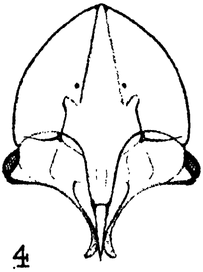
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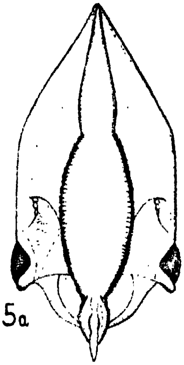
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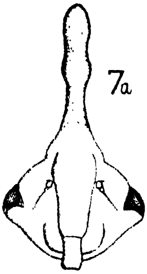
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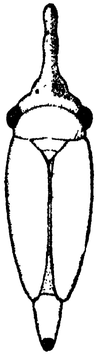
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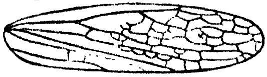
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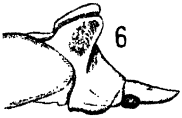
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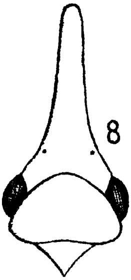
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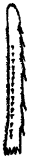
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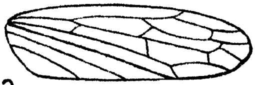
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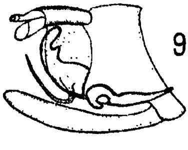
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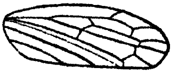
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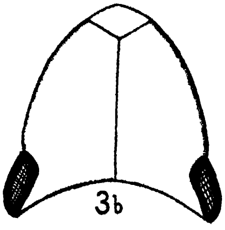
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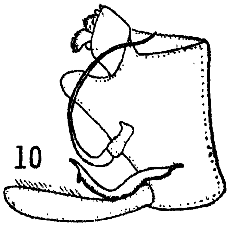
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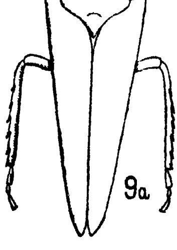
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PLATE XV

Fig. 1a.—*Deltodorydium cooki*, head and thorax, dorsal aspect.
Fig. 1b.—*Deltodorydium cooki*, hind tibia.
Fig. 2a.—*Deltodorydium leai*, head and thorax, dorsal aspect.
Fig. 2b.—*Deltodorydium leai*, male genitalia.
Fig. 3a.—*Deltodorydium viridis*.
Fig. 3b.—*Deltodorydium viridis*.
Fig. 4.—*Deltodorydium brighami*.
Fig. 5a.—*Paradorydium casuarinae*.
Fig. 5b.—*Paradorydium casuarinae*, tegmen.
Fig. 6a.—*Paradorydium menalus*.
Fig. 6b.—*Paradorydium menalus*, aedeagus.
Fig. 7a.—*Anacephaleus minutus*, head and thorax, dorsal aspect.
Fig. 7b.—*Anacephaleus minutus*, male genitalia.
Fig. 8a.—*Anacephaleus carribensis*, head and thorax, dorsal aspect.
Fig. 8b.—*Anacephaleus carribensis*, head, ventral aspect.
Fig. 8c.—*Anacephaleus carribensis*, hind tibia.
Fig. 9.—*Anacephaleus ulopae*, head and thorax, dorsal aspect.
Fig. 10a.—*Anacephaleus simplex*, head and thorax, dorsal aspect
Fig. 10b.—*Anacephaleus simplex*, tegmen.
Fig. 11.—*Anacephaleus subreticulatus*.
Fig. 12.—*Anacephaleus punctatus*, head and thorax in profile.
Fig. 13.—*Procephaleus bulbosa*, head and thorax, dorsal aspect.
Fig. 14.—*Cephalelus brunneus*.
Fig. 15a.—*Austrolopa kingensis*.
Fig. 15b.—*Austrolopa kingensis*, hind tibia.
Fig. 15c.—*Austrolopa kingensis*, tegmen.
Fig 15d.—*Austrolopa kingensis*, aedeagus.
Fig 16a.—*Austrolopa brunensis*, paramere.
Fig 16b.—*Austrolopa brunensis*, aedeagus.
Fig 16c.—*Austrolopa brunensis*, sub-genital plate.

PLATE XV

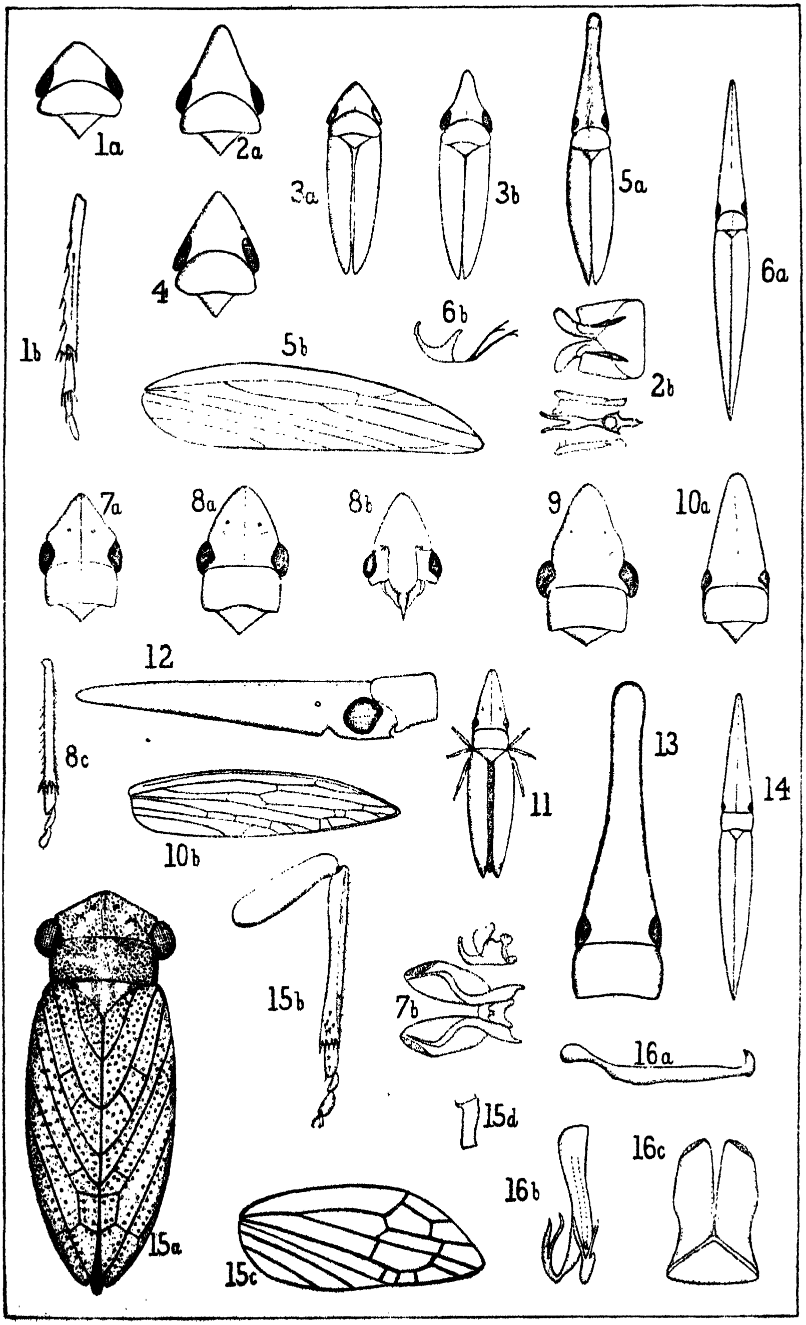
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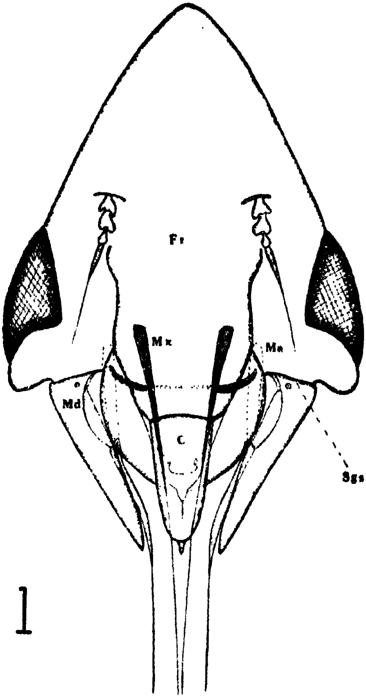
PLATE XVI

Fig. 1.—*Anacephaleus minutus*, head, ventral aspect.
Fig. 2.—*Deltodorydium cooki*, head, ventral aspect.
Fig. 3.—*Austrolopa kingensis*, head, ventral aspect.

c., clypeus
fr., frons
fs., frontal suture
mx., maxilla
md., mandible.
oc., ocellus
sgs., subgenal suture
ma., maxillary apodeme.



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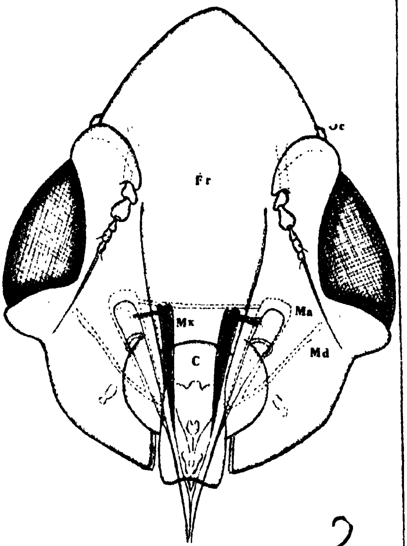

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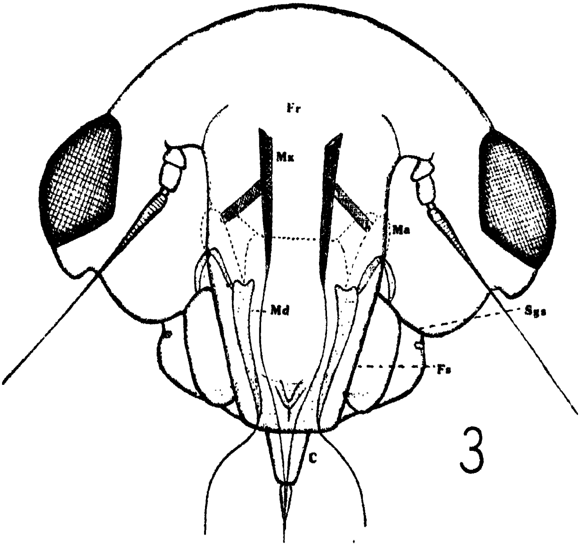

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PAP. & PROC. ROY. SOC. TASMANIA, 1936 (31ST MAY, 1937)

Australian Leaf-Hoppers (Jassoidea, Homoptera)

Part 5

Euscelidae (in part)

By

J. W. EVANS, M.A., F.R.E.S.

PLATES XVII-XIX

(Read 12th October, 1936)

This paper is concerned with the species and genera of two of the tribes of the Euscelinae that occur in Australia. All the species dealt with are arboreal; the majority are confined to eucalyptus trees, and all are relatively large, ranging from 5 to 15 mm. in length. The other genera comprised in this sub-family consist mostly of grass-feeding species; these will be dealt with in a future publication.

The principal purpose of this paper is to render possible the generic identification of the insects considered, and to show the interrelationships between the genera. It has been found impossible to include a redescription of every named species, or even to determine the full extent of the existing synonymy.

The Euscelidae differ from other Jassoid families, in that the apex of the frons is confined entirely to the under-surface of the head, except in some instances for a very narrow border. The vertex occupies all, or nearly all, the upper surface of the head; the ocelli are on, or near, the upper margin of the head, and the suture between the vertex and frons is occasionally not visible. The hind tibiae are strongly flattened, with four rows of fairly long spines along each angle, one row with the spines much thicker and farther apart than in the other rows.

There are three sub-families, the Euscelinae, Balcluthinae, and Eupelicinae. The Balcluthinae are represented in Australia by only two genera, *Pettya* Kirk. and *Nesosteles* Kirk. They are characterized by the very long tegmina, which are more than twice the length of the claval commisure. The Eupelicinae may be divided into two tribes, the Eupelicini and the Paradorydiini. Of these only the Paradorydiini occur in Australia, and are represented by two genera, *Paradorydium* Kirk. and *Deltodorydium* Kirk. The Australian arboreal Euscelinae may be separated into two tribes, which are defined in the following key:

Tegmen with a broad appendix that continues widely round the apex of the tegmen: ambient vein of wing continuing on to the claval area	*Tartessusini*
Tegmen with or without a small narrow appendix; ambient vein of wing terminating at the claval suture . . .	*Thymbrini*

KEY TO THE GENERA OF THE TARTESSUSINI

1. Labium short, not reaching to between the hind legs .	2
Labium long, reaching to between the hind legs . .	*Tartessoides*, gen nov.
Genotype, *Tartessoides griseus*, sp. nov.	
2. Lateral margins of frons, in ventral aspect, straight .	*Tartessella*, gen. nov.
Genotype, *Tartessella attenuata*, sp. nov.	
Lateral margins of frons, in ventral aspect, curved posteriorly towards the eyes	*Tartessus* Stål
Genotype, *Tartessus ferrugineus* Walk.	

Tribe TARTESSUSINI

Tartessus Stål

Öfv. Vet.-Ak. Förh. 22: 156, 1865

This genus contains more species than any of the other genera comprised in both the Tartessusini and Thymbrini. It is not confined to Australia, but extends to New Caledonia, New Guinea, Mysol, the Phillipines, and Cambodia. The following species have previously been described from Australia: *fulvus* Walk., *latifrons* Walk., *australis* Walk., *transversus* Walk. (1851), *semicitrinus* Walk., *signifrons* Walk. (1858b); *australicus* Spanberg, *flavipes* Spanberg (1878); *subniger* Sign., *sahlbergii* Sign. (1880); *syrtidis* Kirk. (1906), *idyia* Kirk., *itonias* Kirk., *issa* Kirk., *iphis* Kirk., *io* Kirk., *ianthe* Kirk., *iambe* Kirk., *ianeira* Kirk., *ianassa* Kirk., *iokaste* Kirk. (1907); *occidentalis* Jac. (1909). Several species are synonymous with *Tartessus fulvus*, and in addition an examination of the paratypes of Kirkaldy's species has shown that *io* is synonymous with *ianthe*, and *ianassa* with *iokaste*. All Walker's species were originally placed in the genus *Bythoscopus*. The same author also described a *Coelidia australis* (1851), which, according to Distant (1908), belongs to the genus *Tartessus*. Mr. China informs me that Distant was in error.

The head may be almost flat or slightly convex, the maxillary plates wide, and the clypeus broad, in some species widening anteriorly. The frons widens posteriorly, and in some species consists of two distinct regions: an anterior oval area, bearing the transverse muscle impressions, and a posterior rectangular area. These two regions may be especially distinct in the nymphs (see Appendix). The hind margin of the frons is distinct, and may be ventral, marginal, or dorsal in position. The ocelli lie between the lateral borders of the frons and the eyes, close to the former. The antennal ledges are distinct, but not pronounced, and the antennal pits shallow. The eyes are large, but not prominent, and the crown of the head in dorsal aspect is wide. The pronotum is produced anteriorly; the anterior border is never parallel with the hind border, and laterally it is narrow. The tegmina have a very wide appendix that continues round the apices of the tegmina, and the ambient vein of the hind wing continues on to the claval area. Many species have one or a few spines on the hind margin of the tegmen arising from the point of commencement of the appendix. The hind tibiae have an armature of strong spines. The rows of largest spines are mounted on enlarged bases, and between each of these are from three to five short, strong spines. In addition there are two rows of strong spines, of which one row comprise longer spines than the other; these may be of unequal lengths. There is also a row of long, hair-like spines. The male genitalia have large pygophores, which bear style-like processes on the internal dorsal margin.

Tartessus fulvus (Walk.)

(Plate XVII, figs. 1a-1e)

Bythoscopus fulvus Walk., *List Homopt.* III, 866, 1851
Bythoscopus latifrons Walk., *op. cit.* 869
Bythoscopus transversus Walk., *op. cit.* 869
Bythoscopus semicitrinus Walk., *Ins. Saund. Homopt.*, 105, 1858
Bythoscopus signifrons Walk., *op. cit.* 106
Tartessus australicus Spanberg, *Öfv. Vet.-Ak. Förh.* 351, 1878
Tartessus subniger Sign. *Ann. Soc. Ent. Fr.* 5 (X), 350, 1880
Tartessus syrtidis Kirk., *Bull. Hawaii Sug. Ass. Ent.* 1 (9), 541, 1906

This species is redescribed here, in spite of the fact that an excellent description was given by Signoret in 1880, because it is by far the most abundant species of the genus *Tartessus* that occurs in Eastern Australia. It is variable as regards coloration, hence the existing synonymy. Numerous figures are given for the purpose of illustrating a typical species belonging to this genus.

Length (from the apex of the head to the tip of the folded tegmina), 9 mm. *Head*, width 2·5 mm. ventral surface whitish-yellow with black markings, eyes greyish-brown, ocelli marginal; crown whitish-yellow, wider against the eyes than in the centre. *Pronotum*, anterior border whitish-yellow, the remainder pale yellowish-brown. *Scutellum*, pale yellowish-brown with brown markings. *Tegmen*, hyaline-brown, veins brown. There are two spines on the anal margin. *Thorax* and *abdomen*, ventral surface, black. *Legs*, coxae black; femora, proximally black, distally pale yellowish-brown; tibiae and tarsi, pale yellowish-brown.

Tartessus obscurus, sp. nov.

(Plate XVII, figs. 5a-5b)

Length, 5 mm. *Head*, width 1·4 mm., pale brownish-yellow, eyes black, head rounded posteriorly, the ocelli, but not the hind margin of the frons, visible in ventral aspect; crown of head from above, slightly produced between the eyes. *Pronotum* and *scutellum*, pale brown; the scutellum is longer than the pronotum. *Tegmen*, pale hyaline-brown, with one spine on the hind margin. *Thorax* and *abdomen*, ventral surface, and *legs* pale brownish-yellow.

Male genitalia, aedeagus as in Plate XVII, fig. 5b.

Type ♂, from Leura, New South Wales (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Tartessus mackerrasi, sp. nov.

(Plate XVII, figs. 4a, 4b)

Length, 6 mm. *Head*, width 1·9 mm., ventral surface black, but for the hind border of the frons and vertex and antennal ledges, which are brown; eyes, dark reddish-brown; crown from above, brown. *Pronotum* and *scutellum*, pale brown, the former slightly longer than the latter. *Tegmen*, hyaline-brown, veins dark brown; a single short spine on the hind margin. *Thorax* and *abodmen*, ventral surface, black. *Legs*, black, but for the tibiae and tarsi of all three pairs of legs, which are marked with a pattern of light and dark brown.

Male genitalia, aedeagus as in Plate XVII, fig. 4b.

Type ♂, from Canberra, F.C.T. (coll. I. Mackerras), in the collection of the C.S.I.R. Division of Entomology at Canberra.

Tartessus pallidus, sp. nov.

(Plate XVII, fig. 7)

Length, 6·5 mm. *Head*, width 2 mm., ventrally very pale brownish-yellow, clypeus and markings on the frons pale brown; eyes, brownish-red. Head, dorsally pale brownish-yellow, slightly produced anteriorly. *Pronotum* and *scutellum*, tawny. *Thorax*, ventral surface, and *legs*, very pale brownish-yellow. *Abdomen*, chocolate-brown.

Type ♀, from Sydney, New South Wales (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Tartessus blundellensis, sp. nov.

(Plate XVII, fig. 6)

Length, 9·5 mm. *Head*, width 1·9 mm., ventrally pale coffee-coloured with whitish markings, but for the clypeus, which is pale straminaceous; eyes, reddish-brown. Dorsal surface of the head with the hind margin of the frons broadly visible. *Pronotum*, pale coffee-coloured with irregular whitish markings. *Scutellum*, dull olive-brown. *Tegmen*, pale hyaline-brown, the veins brown tinged with purple; hind border with a group of four spines. *Thorax* and *abdomen*, ventral surface, and *legs*, pale straminaceous, but for the bases of the spines on the hind tibiae, which are dark brown.

Type ♀, from 'Blundells', F.C.T. (coll. J.W.E.), in the collection of the C.S.I.R. Division of Entomology at Canberra.

Tartessus spinosus, sp. nov.

(Plate XVII, fig. 8)

Length, 6·5 mm. *Head*, width 2·5 mm.; frons and vertex pale brown with dark brown markings; clypeus, maxillary plates, and lorae, pale greyish-brown. *Pronotum*, very pale yellowish-brown mottled with grey. *Scutellum*, pale yellowish-brown with dark brown markings. *Tegmen*, colourless, hyaline; veins distinct, brown. *Thorax* and *abdomen*, ventral surface, pale brown with dark brown markings. *Legs*, pale brown with dark brown markings, excepting the hind tibiae, which are pale yellowish-brown, and the bases of the spines, which are black; femora and tibiae of front two pairs of legs covered with short, sharp spines; hind femora smooth.

Male genitalia, aedeagus short (Plate XVII, fig. 8), pygophores with a divided process attached to the dorsal margin anteriorly; sub-genital plates covered externally with strong spines, each spine having a black base. *Ovipositor*, with the outer sheath covered with short, sharp spines.

Type ♂, from Carnac Island, Western Australia (coll. K. Norris, on *Anthocerus littorea*), in the collection of the Australian Museum, Sydney.

Tartessoides, gen. nov.

The head as seen from below is triangular in shape; the clypeus is widest in the middle and narrowest at the anterior margin. The frons widens posteriorly, the hindmost third having a median ridge and two lateral depressions. The labium is long, reaching as far as the hind coxae, the antennal pits are deep, eyes prominent, and the ocelli are situated at the corners of the posterior margin of the frons, just below the ventral hind border of the head. In dorsal aspect the crown is wide. The pronotum is depressed antero-laterally and raised medianly; the depressed portion is more or less smooth and the elevated portion transversely striated. The apex of the scutellum is raised into a slight hump. The tegmina are long and narrow, the appendix continues widely round the apex of each tegmen, and the veins are somewhat curved (not straight, as with *Tartessus*). The wings have the ambient vein continuing on to the anal area, and the armature of the hind tibiae is similar to that of *Tartessus*.

Tartessoides griseus, sp. nov. (Genotype)
(Plate XVII, figs. 9a-9c)

Length, 10 mm. *Head*, width 2·5 mm., grey mottled with light and dark brown; eyes, brownish-yellow spotted with black. *Pronotum*, grey with very dark brown markings. *Scutellum*, grey barred with black and with a few round black spots. *Tegmen*, hyaline-grey, veins very dark brown; many of the cells with irregularly-shaped dark brown and black areas. *Thorax* and *abdomen*, ventral surface, pale yellowish-brown with dark brown markings.

Type ♀, collected between the Everard Ranges, South Australia, and the Warburton Ranges, West Australia (coll. A. Brumby), in the collection of the South Australian Museum.

Tartessella, gen. nov.

Head from below, lorae small and narrow, the clypeus pear-shaped, and the labium short, reaching as far as the front pair of legs. The frons widens posteriorly, the hind margin being situated at the edge of the dorsal border of the head. The ocelli lie just below the dorsal border of the head, in the corners between the lateral margins of the frons and the ridge that separates the dorsal from the ventral surface of the head. The crown in dorsal aspect is wide and flat, and is wider against the eyes than in the middle. The pronotum is heart-shaped, almost flat, and transversely striated. The venation of the tegmina and of the wings is similar to that described for *Tartessoides griseus*, and the armature of the hind tibiae similar to that of *Tartessus*, but differs in that the small spines that are inserted between the large ones may be few in number and long and delicate instead of short and strong. The pygophores of the male genitalia lack a process.

Tartessella attenuata, sp. nov. (Genotype)
(Plate XVII, figs. 10a-10c)

Length, 11 mm. *Head*, width 2·8 mm., ventral surface pale brown with transverse brown markings on the frons, the vertex mottled with dark brown, and the eyes dark brown. *Pronotum*, dull greyish-brown, with indistinct whitish maculations. *Scutellum*, dull brown.

Tegmen, hyaline, veins brown, with no incomplete cross-veins and no cross-veins on the anal area. *Thorax* and *abdomen*, ventral surface, pale brown. *Legs*, fore and middle tibiae covered with spines; hind tibiae with only a few small spines between the bases of the largest spines.

Male genitalia, as in Plate XVII, fig. 10b. *Ovipositor*, long, pubescent.

Type ♂, from Mullewa, Western Australia (coll. C. May), in the collection of the South Australian Museum.

Tartessella incompleta, sp. nov.

(Plate XVII, fig. 12)

Length, 9 mm. *Head*, width 2·5 mm., pale yellow with yellow markings on the frons, the vertex mottled with brown; eyes, brown mottled with black. *Pronotum*, grey mottled with brown; lateral angles behind the eyes, pale yellow marked with an irregular brown pattern. *Scutellum*, pale yellow with two dark brown lateral longitudinal markings. *Tegmen*, hyaline, colourless; veins with several incomplete cross-veins, especially on the anal area. *Thorax* and *abdomen*, ventral surface, pale yellowish-brown. *Legs*, hind tibiae with the basal spurs of one row of spines large and pointed, the intervening spines few and small.

Male genitalia, aedeagus as in Plate XVII, fig. 12; sub-genital plates, parameres and pygophores similar to those of the genotype.

Type ♂, from Cannamilla, Queensland (coll. H. Hardcastle), in the collection of the South Australian Museum.

Tartessella campbelli, sp. nov.

(Plate XVII, fig. 11)

Length, 8 mm. *Head*, width 2·6 mm.; ventral surface whitish with transverse orange markings on the frons; vertex mottled with pale brown; eyes, grey. *Pronotum* and *scutellum*, grey mottled with apricot yellow. *Tegmen*, whitish-hyaline, veins brown. *Thorax* and *abdomen*, ventral surface, pale brownish-yellow. *Legs*, pale yellow; hind tibiae with long hair-like spines between the bases of the row of the largest spines.

Type ♂, from Newcastle Water, North Australia (coll. T. G. Campbell), in the collection of the C.S.I.R. Division of Entomology at Canberra, F.C.T.

Tribe THYMBRINI

Eight genera are included in this tribe. Two of these are new. Kirkaldy's genus *Alseis* (1907) cannot be identified from his description, but is probably closely related to other genera in the Thymbrini. *Epipsychidion* Kirk. (1906, 1907) also doubtless belongs here.

A figure of the head of the genotype of the latter genus is given (Plate XVIII, fig. 9). This was drawn from the paratype, which unfortunately is no longer available for study, hence neither this genus nor *Alseis* are included in the following key:

KEY TO THE GENERA OF THE THYMBRINI

1. Head angularly produced anteriorly, arrow-shaped; ocelli marginal or on the dorsal surface of the head . .	2
Head not angularly produced; ocelli not visible dorsally	3
2. Eyes, in dorsal aspect, in alinement with the margin of the head; general coloration, pale green	*Hackeriana* gen. nov. Genotype, *Hackeriana huonensis*, sp. nov.
Eyes slightly protuberant, not in alinement with the margin of the head; general coloration, brown . . .	*Rhotidus* Walker Genotype. *Rhotidus cuneatus* Walk.
3. Pronotum steeply declivous; crown of head in dorsal aspect, visible medianly as a very narrow border	*Macroceps* Signoret. Genotype, *Macroceps fasciatus* Sign.
Pronotum not steeply declivous; crown of head visible widely between the eyes	4
4. Pronotum flattened, not evenly convex, the anterior third flat and on a level with the crown of the head . . .	*Putoniessa* Kirkaldy Genotype, *Putoniessa nigra* (Walk.)
Pronotum evenly convex, the anterior third not on a level with the crown of the head	5
5. Crown of head from above, wider in the middle than against the eyes	*Thymbris* Kircaldy Genotype, *Thymbris inachis* Kirk.
Crown of head from above, narrower in the middle than against the eyes, or of even width	*Rhotidoides*, gen. nov. Genotype, *Rhotidoides norfolkensis*, sp. nov.

Genus **Thymbris** Kirkaldy

Bull. Hawaii Sug. Ass. Ent. 3; 49, 1907

Head from below, lorae long and wide, the clypeus narrowing anteriorly and extending well beyond the edge of the maxillary plates. The head is flat and not declivous at its anterior margin. The lateral sutures of the frons are straight, but not parallel to each other up to the antennal ledges, thence they are rounded. The antennal pits are shallow, and the antennal ledges strong, extending almost as far as the eyes on each side. Posterior apex of head arrow-shaped, the apex of the frons pointed and convex. The anterior portion of the frons up to the antennal ledges is flat. The ocelli, which are large, are situated in very shallow depressions on the vertical portion of the vertex, and are nearer to the eyes on each side than to each other.

Head from below, crown widest in the centre, where it is slightly produced anteriorly, and is narrowest at a point half-way between the apex and the eyes. The pronotum is considerably longer than the scutellum, and the propleurae separate the eyes from the bases of the tegmina. Tegmina long, narrowing apically. Ovipositor in female extending to just beyond the apices of the folded tegmina. Male genitalia with long sub-genital plates, short parameres, and pygophores with small distinct processes.

Four described species belong to this genus: *Bythoscopus punctivena* Walker (1858a); *Thymbris inachis* Kirk. and *Thymbris iphianassa* Kirk. (1907); and *Rhotidus aequalis* Dist. (1907). It would appear from the description that *aequalis* Dist. is synonymous with *inachis* Kirk. One new species is described below, and a figure is given of the head of the genotype *Thymbris inachis* Kirk. (Plate XVIII, fig. 8). This genus appears to be confined to the more tropical regions of the continent.

Thymbris melvillinsis, sp. nov.

(Plate XVIII, fig. 7)

Length, 12 mm. *Head*, ventral surface with the anterior two-thirds yellowish-brown with small dark brown markings; posteriorly two or three transverse black bands, one of which is situated on the ventral portion of the vertex, the other or others on the crown or dorsal portion of the vertex. The ocelli are situated on the middle band. *Pronotum* and *scutellum*, pale yellowish-brown regularly mottled with dark brown. *Tegmen*, veins wide. whitish-yellow; tegmen bordering the veins dull brown, elsewhere yellowish-hyaline. *Thorax* and *abdomen*, ventral surface, brown.

Male genitalia, as in Plate XVIII, fig. 7.

Type ♂, from Melville Island (coll. W. D. Dodd), in the collection of the South Australian Museum.

Rhotidoides, gen. nov.

Head from below, anterior margin declivous, lorae wide, and the labium reaching to between the middle pair of legs. The frons, which may be somewhat raised above the lorae and clypeus, is slightly convex, and the lateral sutures are curved. The antennal ledges, which are straight, form an obtuse angle with the lateral frontal sutures. The hind margin of the frons is distinct and rounded, and forms part of a transverse ridge that extends to the eyes on either side. The ocelli are either ventrally placed or on the vertical portion of the vertex, slightly closer to the eyes on each side than to each other, and lying above the transverse ridge. The latter is parallel to the hind margin of the head but not to the antennal ledges. The head in profile is evenly rounded, and from above the crown is wide. The pronotum, which is only slightly longer than the scutellum, is slightly convex. Hind tibiae without any small spines set between the bases of the prominent spines. Male genitalia with the sub-genital plates long, wider apically than at the base, and the parameres hook-shaped. The pygophores are narrow and produced apically, but with no separate thickened processes.

This genus contains two species, both of which are extremely variable in coloration and in the shape of the head. It is probably closely related to *Rhotidus* Walk.

Rhotidoides norfolkensis, sp. nov. (Genotype)

(Plate XVIII, figs. 5a-5e)

Length, 9·6 mm. *Head*, width 3 mm., ventral surface pale yellowish-brown mottled with reddish-brown, slightly darker in colour above the transverse ridge; frons anteriorly on the same plane as the clypeus, the anterior margin of the head only slightly recurved. Dorsal surface, crown variable in shape, either slightly produced so that it is wider in the middle than against the eyes, or evenly rounded and narrower in the middle than against the eyes. *Pronotum*, declivous, brown mottled with white. *Tegmen*, hyaline-brown, with indistinct whitish markings; veins brown with white bars. *Thorax* and *adbomen*, ventral surface, pale yellowish-brown. *Legs*, pale yellowish-brown, but for the apices of the prominent spurs on the hind tibiae, which are black. *Ovipositor*, extending slightly beyond the apices of the folded tegmina.

Male genitalia, with the pygophores narrowing apically, but not greatly produced.

Type ♂, from New Norfolk, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Note.—This species, which has been taken at Sydney as well as in several other localities in Australia, is variable both in shape and in coloration, and in the shape of the posterior margin of the head in dorsal aspect. Specimens may be pale reddish-brown or dark chocolate brown, and differ in the amount of white markings present.

Rhotidoides montana, sp. nov.

(Plate XVIII, figs. 6a-6c)

Length, 6 mm., 7 mm. *Head*, width 2 mm., ventral surface pale or dark brown with or without yellowish mottlings. There is usually a broad, pale, brownish-yellow transverse stripe across the posterior third of the frons extending to the eyes on each side. Anteriorly the frons is slightly swollen, and the anterior margin of the head is slightly recurved; posteriorly the head is evenly rounded, not produced, the ocelli lying in shallow depressions. Crown of head in dorsal aspect, of equal width throughout, or wider against the eyes than in the middle. *Pronotum* and *scutellum*, light or dark brown mottled with grey. *Tegman*, hyaline or hyaline-brown with or without whitish mottlings. *Thorax* and *abdomen*, ventral surface, pale yellowish-brown. *Legs*, pale yellowish-brown, but for the bases of all the spines on the hind tibiae, which are black. *Ovipositor*, not extending beyond the apices of the folded tegmina.

Male genitalia with the pygophores narrowly produced posteriorly.

Type ♂, from Mount Wellington, Tasmania, in the collection of the Australian Museum, Sydney.

Note.—This is another very variable species, both in coloration and in the shape of the crown of the head. Although this species has been taken at sea-level in Southern Tasmania, it appears to be largely a mountain form, having been collected at Leura, in the Blue Mountains, Mount Kosciuscko, Canberra, and on the Bogong Plains, Victoria.

Genus **Rhotidus** Walker

Journ. Ent. 1; 318, 1862

Rhothidus Stal, Öfr. Vet.-Ak. Förh. 22; 157, 1865

This genus is closely related to *Thymbris* Kirk., differing principally in the produced arrow-shaped head, dorsal position of the ocelli, and in the structure of the male genitalia.

Head from below, the antennal pits are shallow and the frons widens considerably posteriorly, the hind margin terminating at the apex of the head. The frons is flat anteriorly; posteriorly it is raised into a longitudinal ridge. From the posterior margin of the frons to the eyes on each side is a ridge which separates the dorsal from the ventral surface of the head. The ocelli are on the dorsal surface of the head, either close to or well away from the anterior margin. The pronotum in most species is steeply declivous and much longer than the scutellum. The propleurae narrowly separate the eyes from the bases of the tegmina. The tegmina narrow posteriorly. The hind tibiae have minute hair-like spines, not set on distinct bases, between the basal spurs of the largest spines. The ovipositor extends well beyond the folded tegmina, and the male genitalia have pygophores without any processes, and parallel-sided subgenital plates.

Eight described species can be placed in this genus: *Rhotidus cuneatus* Walk. (1862) (Genotype); *Rhotidus stali* Kirk. (Stål 1865, Kirk. 1907); *R. convivus* Stal; *R. leucostictus* Stål; *R. breviceps* Stål (1865); *Ledra teliformis* Walk.; *L. cuspidata* Walk.; *L. navicula* Walk. (Walk., 1851, a, b; Dist., 1907).

The seven species described by Kirkaldy (1906), and placed in the this genus, do not belong to the Euscelidae, but to the Ledridae. Four new species are described below. Species in this genus differ from each other in the relative length of the head, position of the ocelli, and shape of the ventral surface of the head.

Rhotidus leurensis, sp. nov.

(Plate XIX, figs. 1a, 1b)

Length ♀, 16 mm. *Head,* width 3·8 mm., ventral surface pale brown, not recurved anteriorly; frons almost flat anteriorly; posteriorly, to the antennal ledges it is raised medianly into a longitudinal ridge bordered by shallow troughs; antennal pits shallow. Dorsal surface dark brown, arrow-shaped, rounded apically; greater in length than the scutellum, laterally emarginate; distance from the ocelli to the apex of the head greater than the distance between the ocelli and the eyes on each side. *Pronotum,* dark brown, not steeply declivous. *Tegmen,* hyaline-brown with indistinct whitish maculations. *Thorax* and *abdomen,* ventral surface, and *legs,* pale brown.

Type ♀, from Leura, New South Wales (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Rhotidus insularis, sp. nov.

(Plate XIX, fig. 4)

Length (♀), 12·5 mm. *Head,* width 3 mm., ventral surface pale brownish-yellow mottled with brown, slightly recurved anteriorly; frons evenly convex anteriorly, and with a median longitudinal ridge posteriorly. Dorsal surface marked with a pattern of light and dark brown, shorter than the scutellum; distance between the ocelli and the apex of the head only slightly greater than between the ocelli and the eyes on each side; medianly a longitudinal ridge, laterally straight, not emarginate. *Pronotum,* brown mottled with white. *Scutellum,* brown. *Tegmen,* hyaline-brown mottled with white, the white markings slightly raised and blister-like. *Thorax* and *adbomen,* ventral surface, and *legs,* pale brownish-yellow.

Type ♀, from Launceston, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

Rhotidus wilsoni, sp. nov.

(Plate XIX, fig. 2)

Length (♀), 14 mm. *Head,* width 3·5 mm., ventral surface pale brownish-yellow, slightly recurved anteriorly; frons with a median longitudinal ridge posteriorly. Dorsal surface, khaki-coloured mottled with pale buff, with a median longitudinal ridge; ocelli a little closer to the eyes on each side than to the apex of the head; sides of the head straight, apex rounded. *Pronotum*, concolorous with the head, declivous. *Scutellum*, concolorous with the pronotum, but for the anterior lateral angles, which are brown. *Tegmen*, pale ochreous-brown mottled with white markings, of which the largest and most distinct occur on the veins. *Thorax* and *abdomen*, ventral surface, and *legs*, pale brownish-yellow.

Type ♀, from Millgrove, Victoria (coll. F. E. Wilson), in the collection of the Australian Museum, Sydney.

Rhotidus kiatensis, sp. nov.

(Plate XIX, figs. 3a, 3b)

Length (♂), 12 mm. *Head*, width 3·8 mm., ventral surface pale yellowish-brown mottled with dark brown and black; antennal pits deep, antennal ledges distinct; frons flat anteriorly, posteriorly a wide median longitudinal ridge with deep depressions on either side. Dorsal surface declivous, apricot-yellow mottled with black. There is no distinct division between the dorsal and ventral surfaces of the head as with other species, so that the antennal ledges against the eyes are almost on the same plane as those parts of the posterior margin of the crown that lie immediately behind them. *Pronotum*, steeply declivous, black mottled with yellow, propleurae wide. *Scutellum*, concolorous with the pronotum. *Tegmen*, dark hyaline-brown mottled with grey or white. *Thorax* and *abdomen*, ventral surface, pale brown. *Legs*, pale brown with dark brown and black markings.

Type ♂, from Kiata, Victoria (coll. F. E. Wilson), in the collection of the Australian Museum, Sydney.

Genus **Putoniessa** Kirkaldy

Bull. Hawaii Sug. Ass. Ent. 3; 50, 1907

Head ventrally wide, more or less flat, excepting anteriorly, where the anterior two-thirds of the clypeus and the anterior margin of the lorae are recurved. The antennal pits are shallow. The hind margin of the frons is distinct, straight or slightly rounded; from the hind border to the eyes on each side is an indistinct ridge, not parallel to the antennal ledges. The ocelli are ventrally placed, not touching the frons, and lying postero-laterally to the hind margin of the frons. The pronotum is more or less flat, transversely striated, and almost twice the length of the scutellum. The tegmina are long and narrow apically, and the appendices are very narrow and do not reach to the apices of the tegmina. The hind tibiae are strongly spinose, and lack minute spines between the largest spines (those set on enlarged bases), but a row of long spines that arise direct from the tibiae have small spines set between them at the distal end. Male genitalia with broad sub-genital plates, wrench-shaped parameres, and pygophores with thickened apical processes.

Five described species belong to this genus: *Gypona nigra* Walk. (1862), *Bythoscopus rivularis* Walk., *B. dorsalis* Walk. (1851), *B. repletus* Walk. (1858a); and *Putoniessa dignissima* Kirk. (1907). *P. dignissima* is a synonym of *nigra* Walk., and *repletus* and *dorsalis* are synonymous with *rivularis*. Two news species are described below, and a redescription given of the genotype *Putoniessa nigra* Walk. and of *Putoniessa rivularis*.

Putoniessa nigra (Walker)

(Plate XVIII, figs. 1a-1c)

Gypona nigra Walk. *Jour. Ent.* 1; 319, 1862
Putoniessa dignissima Kirk. *Bull. Hawaii Sug. Ass. Ent.* 3; 50, 1907

Length, 8-10 mm. *Head*, rugose, black with pale brown or yellowish maculations. Ventral surface nearly as long as wide; frons with a median depression close to the hind border, ocelli well away from the hind margin of the frons. Edges of the head, separating the crown from the ventral surface of the head, sharp and well-defined. Crown of head, slightly wider against the eyes than in the middle. *Pronotum*, concolorous with the head, with a narrow depressed border lying against the crown, not extending as far as the eyes on each side; the remainder convex and transversely striated. *Tegmen*, black or dark brown with irregularly-shaped white and hyaline areas, ranging in size from small spots to extensive markings. *Thorax* and *abdomen*, ventral surface, and *legs*, black with pale brown markings.

Male genitalia, as in Plate XVIII, fig. 1c.

Distribution: Queensland and New South Wales.

Putoniessa rivularis (Walker)

(Plate XVIII, fig. 4)

Bythoscopus rivularis Walk. *List Homoptera* III; 865, 1851
Bythoscopus dorsalis Walker, *List Homoptera* III; 867, 1851
Bythoscopus repletus Walker. *Supplement* 267, 1858

Length, 8-10 mm. *Head*, chestnut-brown with pale brown and black markings; ventrally much wider than long, the frons with a slight median depression close to the posterior border, ocelli close to the hind margin of the frons; apical margin of head evenly rounded. Crown from above much wider against the eyes than in the middle. *Pronotum*, pale brown with dark brown markings, almost flat, the anterior border being only at a slightly lower level than the rest of the pronotum. *Tegmen*, mottled with an irregular pattern of brown and white, the white areas opaque or hyaline. *Thorax* and *abdomen*, ventral surface, and *legs*, marked with a variable pattern of light and dark brown.

Male genitalia, as in Plate XVIII, fig. 4.

Distribution: New South Wales, Victoria, South Australia, and Tasmania.

Putoniessa maculata, sp. nov.

(Plate XVIII, figs. 3a, 3b)

Length, 8 mm. *Head* marked with an irregular pattern of pale brownish-yellow and black, ventrally much wider than long; lateral frontal sutures above the antennal ledges parallel to each other, and the ridge separating the frons from the vertex almost straight. Ocelli close to the hind margin of the frons on the vertical portion of the vertex. Crown evenly rounded, not separated from the ventral portion of the vertex by a sharp edge, slightly wider against the eyes than in the middle. *Pronotum*, concolorous with the head, and, excepting for the flat border behind the head, transversely striated. *Tegmen*, black or dark brown with irregular hyaline and white areas, of which the smaller are more or loss circular or oval in outline; veins distinct, pale brown. *Thorax* and *abdomen*, ventral surface, and *legs*, black and dark brown with pale brownish-yellow markings.

Male genitalia, as in Plate XVIII, fig. 3b.

Type ♂, from Seven-Mile Beach, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Note.—This species, which in coloration resembles *P. nigra* and in structure *P. rivularis*, was found in large numbers under the bark of Eucalyptus trees.

Putoniessa galliensis, sp. nov.

(Plate XVIII, fig. 2)

Length, 7 mm. *Head*, pale brown with black and whitish markings, nearly as long as wide. Anterior border of head not so steeply declivous as in other species in the genus, ocelli on vertical part of vertex; vertex evenly rounded. Dorsal surface, medianly produced, so that the crown is slightly wider in the middle than against the eyes. *Pronotum*, heart-shaped, almost flat, grey with irregular black and brown markings. *Tegmen*, hyaline and white, marked with a pattern of light and dark brown; the pattern, which has a longitudinal axis, may continue on to the pronotum. *Thorax* and *abdomen*, ventral surface, and *legs* brown.

Type ♀, from Leura, New South Wales (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Genus **Macroceps** *Signoret*

Ann. Soc. Ent. Fr. 5 (X): 364, 1880

The labium reaches to between the middle pair of legs, and the lorae are swollen. The anterior border of the head, up to and including the anterior third of the frons, is at right angles to the posterior border of the head. The frons is swollen anteriorly and flat posteriorly; the hind margin is distinct, and may be straight or slightly rounded. An indistinct ridge extends from the hind border of the frons to the eyes on each side, and is more or less parallel to the antennal ledges. The vertex is vertical; the ocelli are thus neither dorsal nor ventral in position, and are close to, but not touching, the posterior border of the frons. The pronotum is steeply declivous, so that of the head, from above, only the eyes and a very narrow border of the crown are visible. The tegmina do not narrow posteriorly, and the last ventral abdominal segment in the female is not divided.

Note.—Insects in this genus superficially resemble *Ipo* spp. Only one previously described species belongs to this genus; two new species are described below. Unfortunately, as no males are available, the structure of the male genitalia cannot be figured for comparison with those of species in other genera dealt with.

Macroceps fasciatus Signoret

(Plate XIX, figs. 8a-8c)

Macroceps fasciatus Sign. *Ann. Soc. Ent. Fr.* 5 (X): 364, 1880

The redescription given below was made from a single specimen, collected at Kangerilla, South Australia.

Length, 5 mm. *Head*, width 2·5 mm., anterior half pale brown mottled with dark brown; posterior half chestnut-brown; ocelli red, eyes brown. *Pronotum*, chestnut-brown, with an indistinct median longitudinal black stripe. *Scutellum*, chestnut-brown. *Tegmen*, hyaline-brown; apically pale brown; proximally a white oblique fascia extends from the anal angle to the costal border. *Thorax*, ventral surface, pale brown. *Legs*, yellowish-brown with brown markings. *Abdomen*, ventral surface, pale yellowish-brown.

Macroceps tonnoiri, sp. nov.

(Plate XIX, fig. 10)

Length, 7 mm. *Head*, width 3 mm., the anterior half dark brown mottled with yellow, the posterior half grey mottled with brown and black. *Pronotum*, light brown mottled with dark brown, and with a broad median longitudinal black stripe. *Scutellum*, chestnut-brown. *Tegmen*, opaque or hyaline with white, brown, and black markings;

the white markings may form a fascia across the tegmen or be absent; veins with black bars. *Thorax*, ventral surface marked with a pattern of light and dark brown. *Legs*, front two pairs black, the proximal halves of the front femora pale brown and the distal halves black; hind tibiae and tarsi light brown, but for the apices and bases of the spines, which are black. *Abdomen*, ventral surface light brown, genital segments dark brown.

Type ♀, from Mount Kosciusko, New South Wales (coll. A. L. Tonnoir), in the collection of the C.S.I.R. Division of Entomology at Canberra.

Note.—This species has also been taken at Hobart, Tasmania.

Macroceps tamarensis, sp. nov.

(Plate XIX, figs. 9a-9c)

Length, 6·5 mm. *Head*, width 2·8 mm., pale brown, ocelli red, eyes greyish-brown; frons less convex anteriorly than with *M. tonnoiri*, and the lorae more declivous. *Pronotum* and *scutellum*, pale chestnut-brown mottled with yellowish-brown. *Tegmen*, hyaline, suffused with pale brown; veins barred with brown and white. *Thorax*, ventral surface, and front two pairs of legs brown, hind tibiae pale brown, but for the apices of the tibiae and the bases of the spines, which are dark brown. *Abdomen*, ventral surface brown.

Type ♀, from Launceston, Tasmania, in the collection of the South Australian Museum.

Hackeriana, gen. nov.

This genus comprises species which superficially resemble *Rubria* spp. (Ledridae) in coloration and shape. The structure of the male genitalia suggests relationship with *Putoniessa*, whilst the fact that the head is similarly shaped to those of *Rhotidus* is of little significance. All known species in this genus are pale green, thus differing from other species described in this paper, which are largely brown or black.

Head from below, slightly transversely convex, the apex of the clypeus slightly depressed and the lorae wide. The antennal pits are shallow and the antennal ledges indistinct. The apical margin of the head is arrow-shaped, and the ocelli marginal or just on the dorsal surface of the head. The eyes are not prominent, and the crown is much wider in the middle than against the eyes. The propleurae narrowly separate the eyes from the bases of the tegmina. In the female the abdomen extends beyond the apices of the folded tegmina. The male genitalia consist of wide parallel-sided subgenital plates and short parameres. The pygophores have large thickened processes, but are not produced posteriorly.

Hackeriana huonensis, sp. nov. (Genotype)

(Plate XIX, figs. 6a, 6b)

Length, 7 mm. General coloration, yellowish-green. *Head,* width 2·5 mm., eyes reddish-brown. A transverse white line on the apical margin of the head separates the ventral from the dorsal surface. Crown flat, ocelli pale red, slightly nearer to the eyes than to the apex of the head. Apex of head rounded, not acute. *Tegmen,* hyaline, costal margin anteriorly green; veins pale green.

Type ♂, from Huonville, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Hackeriana glauca, sp. nov.

(Plate XIX, fig. 7)

Length, 7·5 mm. General coloration, pale greenish-yellow. *Head,* width 2·5 mm.; eyes brownish-red. The white line on the apical margin of the head is bordered narrowly on each side with brown. Crown with a shallow median longitudinal depression; ocelli nearer to the eyes on each side than to the apex of the head. *Tegmen,* pale yellowish-hyaline, veins pale green.

Type ♂, from Adelaide, South Australia (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Hackeriana rotundata, sp. nov.

(Plate XIX, fig. 5)

Length, 8·2 mm. General coloration, pale greenish-yellow. *Head,* width 2·5 mm., more swollen apically, less flattened, and more elongate than with the preceding species. Apically a white stripe bordered with brown; ocelli much closer to the eyes on each side than to the apex of the head. *Pronotum,* more convex than with the preceding species. *Tegmen,* hyaline, veins green.

Type ♀, from Vivonne Bay, Kangaroo Island, in the collection of the South Australian Museum.

Discussion

The relationship of the genera described in this paper to genera in other Jassoid families is somewhat obscure. *Rhotidus* spp. have in the past been linked up with the Ledridae because their ocelli are dorsally placed. Several species of *Tartessus* described by Walker were placed in the genus *Bythoscopus* because their ocelli are more or less ventral in position, and Kirkaldy considered that *Putoniessa dignissima* formed a link between the Jassidae and Bythoscopidae, and pointed the way to the Stenocotidae.

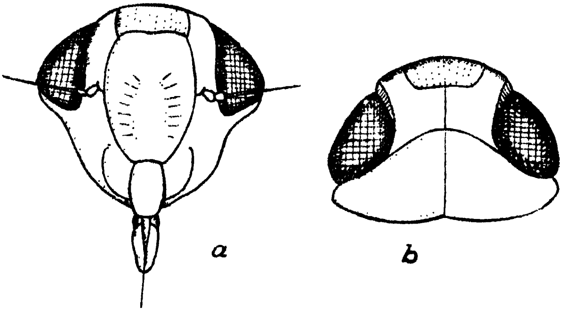
Relationships between genera cannot be decided by the position of the ocelli alone. Whilst it is probable that the primitive position of the ocelli amongst Jassoid insects was a ventral one, some primitive families, as, for instance, the Ulopidae, have the ocelli dorsally placed. A tendency is evident in many genera for the ocelli to move from a ventral position to a marginal, and finally a dorsal, one. This change-over may frequently be correlated with a progressive elongation of the head. The venation of the tegmen throughout the whole family is remarkably similar, and although venational characters are thus seldom a guide to relationships, they do serve to separate the Tartessusini from the Thymbrini. The continuation of the ambient vein of the wing on to the claval area, as occurs in all three genera of the Tartessusini, is an unusual feature. The shape and armature of the hind tibiae, especially of *Macroceps* spp., suggest relationships with the Eurymelidae. However, the male genitalia of other genera discount such a relationship, since their structure, especially as regards the large pygophore and pygophore process, is in no way Eurymeloid.

As with the Eurymelidae and Bythoscopidae, an apparent intrinsic difference in specific differentiation is evident in the various genera. Some genera *(Tartessus)* have numerous well-defined species, a few of which are widely distributed, and others apparently localised. Some genera *(Rhotidus)* have a large number of well-defined species, none of which have a wide distribution, specific differentiation having rapidly followed geographical isolation. With other genera *(Rhotidoides)* geographical isolation has resulted in a large number of colour varieties, and even in varieties that have minor structural differences, but has given rise to no new fixed species.

As with other papers in this series, I am indebted to Mr. W. E. China, of the British Museum, for considerable assistance and encouragement.

APPENDIX

In both this and earlier papers of a similar nature, in descriptions concerned with head structures, the large median plate bearing transverse muscle impressions has been referred to as the 'frons,' and the small rectangular plate that lies directly in front of the frons as the 'clypeus,'. In a recent publication Snodgrass (1935) brings evidence to show that this terminology does not represent the true homologies of the plates in question. He considers that the large plate, from which the dilator muscles of the sucking-pump arise, belongs to the clypeal region. This is because in his opinion the sucking-pump is part of the mouth cavity and not part of the pharynx. Whilst not disputing Snodgrass's interpretation in so far as it concerns the cicada, where a median ocellus occurs on a small triangular plate immediately behind the large swollen plate, it would appear from the available evidence that with the jassoids and cercopids, where there is no median ocellus, Snodgrass's postclypeus and the frons of the present author is in reality the fronto-clypeus.



Text-fig. 1.—*a*. Head of a nymph of *Tartessus* sp., ventral aspect.
b. Head of a nymph of *Tartessus* sp., dorsal aspect.

Text-figures 1a and 1b represent the head of a nymph of *Tartessus* sp. in ventral and dorsal aspect. In the nymphs of leaf-hoppers in this genus a distinct rectangular plate occurs behind the sclerite that bears the muscle impressions. This plate is doubtless the frons. In adult *Tartessus* spp. the two plates are fused (Plate XVII, fig. 1a).

Further evidence that the large median sclerite comprises both part of the clypeus and part of the frons in jassoids, is supplied by a study of nymphs of species belonging to many genera. In these a Y-shaped suture occurs above the large median sclerite, the arms of the Y lying on each side of its posterior margin. This suture is doubtless the epicranial suture, the divergent arms of which mark the boundary between frons and vertex.

In some cercopids the frons is also not a distinct sclerite, though in some species, as, for instance, *Petyllis australiensis* Kirk., it may be seen as a small rectangular plate on the crown of the head. In the nymphs of many cercopids, for example, *Bathylus albicincta* Erichs., a small triangular plate, bounded laterally by distinct sutures, occurs posterior to the large swollen postclypeus. The two plates are separated from each other by a shallow groove. In the adults the groove is not apparent, the two plates appearing as one.

Since the terms 'anteclypeus' and 'frontoclypeus' are somewhat unwieldy, it is not proposed to employ them in purely taxonomic works, and a continued use will be made of the words 'clypeus' and 'frons' respectively.

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PLATE XVII

Fig. 1a.—*Tartessus fulvus*, head, ventral aspect.
Fig. 1b.—*Tartessus fulvus*, tegmen.
Fig. 1c.—*Tartessus fulvus*, wing.
Fig. 1d.—*Tartessus fulvus*, hind tibia.
Fig. 1e.—*Tartessus fulvus*, male genitalia.
Fig. 2.—*Tartessus io*, aedeagus.
Fig. 3.—*Tartessus idyia*, aedeagus.
Fig. 4a.—*Tartessus mackerrasi*, head and thorax, dorsal aspect.
Fig. 4b.—*Tartessus mackerrasi*, aedeagus.
Fig. 5a.—*Tartessus obscurus*, head and thorax, dorsal aspect.
Fig. 5b.—*Tartessus obscurus*, aedeagus.
Fig. 6.—*Tartessus blundellensis*, head and thorax, dorsal aspect.
Fig. 7.—*Tartessus pallidus*, head and thorax, dorsal aspect.
Fig. 8.—*Tartessus spinosus*, aedeagus.
Fig. 9a.—*Tartessoides griseus*, tegmen.
Fig. 9b.—*Tartessoides griseus*, head, ventral aspect.
Fig. 9c.—*Tartessoides griseus*, head and thorax, dorsal aspect.
Fig. 10a.—*Tartessella attenuata*.
Fig. 10b.—*Tartessella attenuata*, male genitalia.
Fig. 10c.—*Tartessella attenuata*, head, ventral aspect.
Fig. 11.—*Tartessella campbelli*, head and pronotum, dorsal aspect.
Fig. 12.—*Tartessella incompleta*, aedeagus.

PLATE XVII

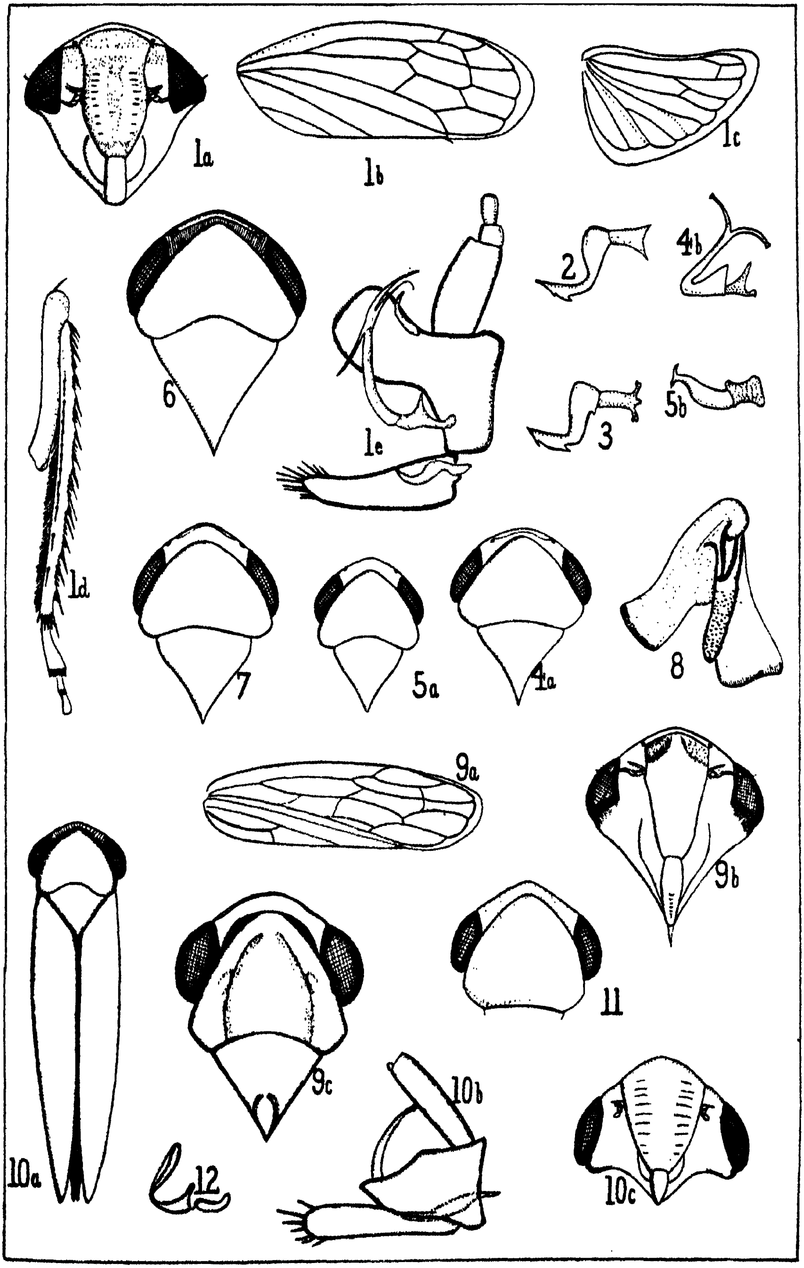

Plate XVIII

Fig. 1a.—*Putoniessa nigra*, hind tibia.
Fig. 1b.—*Putoniessa nigra*, head, ventral aspect.
Fig. 1c.—*Putoniessa nigra*, male genitalia.
Fig. 2.—*Putoniessa gallicensis*, head and thorax, dorsal aspect.
Fig. 3a.—*Putoniessa maculata*, head and thorax, in profile.
Fig. 3b.—*Putoniessa maculata*, male genitalia.
Fig. 4.—*Putoniessa rivularis*, aedeagus.
Fig. 5a.—*Rhotidoides norfolkensis*, head and thorax, dorsal aspect.
Fig. 5b.—*Rhotidoides norfolkensis*, male genitalia.
Fig. 5c.—*Rhotidoides norfolkensis*, tegmen.
Fig. 5d.—*Rhotidoides norfolkensis*, wing.
Fig. 5e.—*Rhotidoides norfolkensis*, head, ventral aspect.
Fig. 6a.—*Rhotidoides montana*, male genitalia.
Fig. 6b.—*Rhotidoides montana*, head and thorax, in profile.
Fig. 6c.—*Rhotidoides montana*, head and thorax, dorsal aspect.
Fig. 7.—*Thymbris melvillensis*, male genitalia.
Fig. 8.—*Thymbris inachis*, head and thorax, in profile.
Fig. 9.—*Epipychidion epipyropis*, head, ventral aspect.

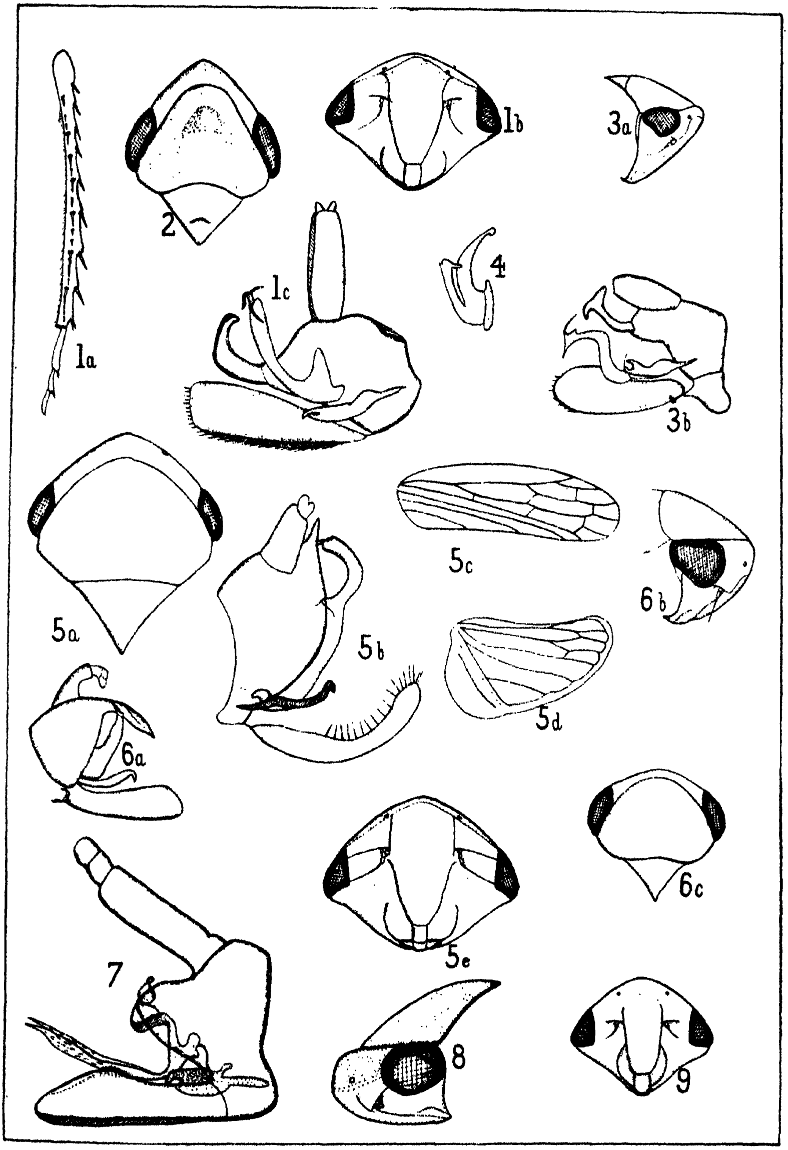
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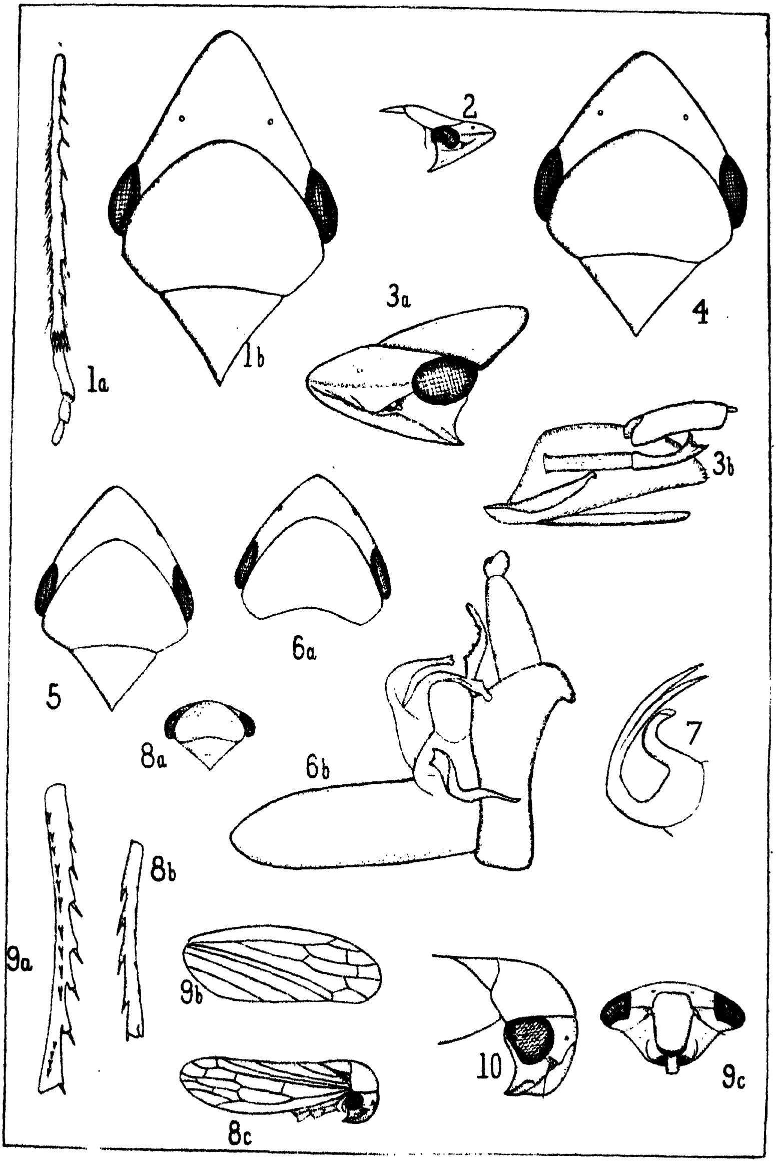
PLATE XIX

Fig. 1a.—***Rhotidus leurensis***, hind tibia.
Fig. 1b.—***Rhotidus leurensis***, head and thorax, dorsal aspect.
Fig. 2.—***Rhotidus wilsoni***, head and thorax, in profile.
Fig. 3a.—***Rhotidus kiatensis***, head and thorax, in profile.
Fig. 3b.—***Rhotidus kiatensis***, male genitalia.
Fig. 4.—***Rhotidus insularis***, head and thorax, dorsal aspect.
Fig. 5.—***Hackeriana rotundata***, head and thorax, dorsal aspect.
Fig. 6a.—***Hackeriana huonensis***, head and thorax, dorsal aspect.
Fig. 6b.—***Hackeriana huonensis***, male genitalia.
Fig. 7.—***Hackeriana glauca***, aedeagus.
Fig. 8a.—***Macroceps fasciatus***, head and thorax, dorsal aspect.
Fig. 8b.—***Macroceps fasciatus***, hind tibia.
Fig. 8c.—***Macroceps fasciatus***, in profile.
Fig. 9a.—***Macroceps tamarensis***, hind tibia.
Fig. 9b.—***Macroceps tamarensis***, tegmen.
Fig. 9c.—***Macroceps tamarensis***, head, ventral aspect.
Fig. 10.—***Macroceps tonnoiri***, head and thorax, in profile.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PAP. & PROC. ROY. SOC. TASMANIA, 1936 (31ST MAY, 1937)

The Occurrence of Fossil Plants at Warrentinna, Tasmania

By

ISABEL C. COOKSON, D.Sc.
(Communicated by P. B. Nye, M.Sc.[1])

PLATE XX

(Read 12th October, 1936)

INTRODUCTION

An outcrop in which plant-remains of early Palaeozoic type occur is situated in the railway-cutting 8 chains south of Warrentinna Railway-station, in North-Eastern Tasmania. My attention was drawn to this locality by Mr. P. B. Nye, M.Sc., whose kindly assistance with arrangements for a visit to the area I wish to acknowledge. The actual discovery there of fossil-plants is due to Mr. F. Blake, of the Geological Survey of Tasmania. Mr. Blake very generously provided me with detailed plans and directions by which I was able to find and work the fossiliferous beds more exhaustively than he had previously had time to do. The results of this work at Warrentinna, though unsatisfactory on account of the imperfect and fragmentary nature of the specimens obtained, are recorded here in the hope that interest may be stimulated in Tasmania which will lead to the discovery of new fossiliferous beds in the same rock series. The sedimentary rocks exposed in the railway-cuttings between Branxholm and Tarlita stations belong to the Mathinna series, and have been referred by Nye (1925) to the Cambro-Ordovician period. He says that 'no fossils have been found in this series of rocks anywhere in the north-eastern part of Tasmania, so that their age cannot be definitely determined, and they are referred to the Cambro-Ordovician system. The same belt extends southwards to the Alberton and Mathinna goldfields, and is found in other localities in the north-east of Tasmania, and is referred to as the Mathinna slates and sandstones. The similar strata of the Balfour and Bischoff slates and sandstones in North-Western Tasmania are correlated with this series. Lithologically and structurally it is very similar to the Ordovician system in Victoria, but no graptolites have yet been found in it.'

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[1] In communicating this paper Mr. Nye makes the following remarks:—

'The plant-remains referred to in this paper were discovered by Mr. F. Blake, Field Geologist, on 15th February, 1934, while engaged in a survey of the Warrentinna goldfield. The location of the discovery is a railway-cutting eight chains south of the Mara siding, on the Launceston-Herrick railway. The plant-remains are contained in fine-grained sandstones, interbedded with slates, which strike north and south and dip westerly at 66 degrees.

'Owing to the doubt as to their origin, little time was spent in the examination, and only a few specimens were collected. The specimens were brought to the notice of Dr. Cookson, and finally arrangements were made by Dr. Cookson to visit the site of the discovery. Further collections were made and examined by Dr. Cookson, and the following paper is the result.

'While the Mathinna series of slates and sandstones are referred by the Geological Survey of Tasmania to the Cambro-Ordovician System, there is no direct evidence for such, and the series might possibly belong to the Silurian System.

'This discovery is the first one in Tasmania of fossil plant-remains older than the Permo-Carboniferous period, and is therefore of considerable scientific interest.'

—*Editor, Papers & Proc.*

The rocks of the cutting at Warrentinna consist of slates and sandstones. The latter are pink or yellow in colour, and most are fine-grained. The plant-remains occur in a few narrow beds of sandstone adjacent to bands of slates. The fracture of the sandstone is very uneven, so that only small lengths of plant-stems are evident on the exposed surfaces. These are preserved as flattened incrustations in the sandstone. In the majority of examples the flattened cast of matrix is enclosed by a thin layer of a brown mineral which represents the transformed outer tissues of the stem. Occasionally, as in fig. 6, small carbonaceous particles may remain on the outer surface of the incrustation, or, as in fig. 2, on the inner surface of the concave mould after removal of the core of matrix.

DESCRIPTION OF PLANT REMAINS

The plant-fragments collected at Warrentinna are of strikingly uniform character, and are devoid of special diagnostic features. For this reason they cannot be specifically identified, and only tentative comparisons can be made. Most are unbranched, smooth stems, from 1-5 mm. in width and 6 cms. or less in length. The longest piece of stem found is represented of natural size in fig. 1. It has a width of 2 mm., and a length of 6 cms. is exposed on the rock. The surface is non-striated, and shows no evidence of appendages. A similar fragment is shown in fig. 2. In this case the core of matrix has fallen out from the greater part of the incrustation, and has left a thin layer of brown material, with small carbonaceous particles to represent the outer tissues of the stem. Fig. 3 represents another stem-fragment, 2 mm. wide and 3·5 cms. long. The incrustation in this case is much flattened, and in the upper portion the sandy cast has come away, exposing a median longitudinal ridge. It is possible that this ridge indicates the position in the stem of a median vascular strand, but there is no evidence to substantiate this.

A few branched stems were found at Warrentinna. These provide more definite characters for comparison with early plants from other countries, and therefore are of greater value than the more numerous unbranched fragments. The specimen shown of natural size in fig. 4 shows the division of a stem 5 mm. wide into two equal daughter-axes. The latter are each 4 mm. in breadth. A second branched example is represented at a magnification of 5 diameters in fig. 6. In it the relatively main axis, which has a diameter of 1 mm., gives off at right-angles a small lateral branch. Both examples are disconnected pieces of stem, and have a Y-shaped form. Their appearance suggests that the branching was probably based on a dichotomy.

Although the fragments just described cannot be specifically identified, a comparison with fossil plants from other localities is fully justified. The age of the Warrentinna plants is not actually determined, but is clearly pre-Devonian, since the Mathinna series are intruded by granites of Devonian age. The natural comparison is therefore with the Silurian plants of Eastern Victoria. Plant-containing beds of Upper Silurian age occur on the mainland along the Walhalla Geosyncline at Gaffney's Creek, Wood's Point, Walhalla, and further south on the coast at Livingstone Creek, Waratah Bay (Lang and Cookson, 1927, 1935). From these localities slender, smooth, branching stems of similar type to those from Warrentinna have been described under the form-genus *Hostimella* sp. Some have shown a more detailed comparative feature in the presence of a small oval area on the surface of the incrustation in the angle between the main axis and the branch. This axillary 'bud' is also represented in some of the smooth-branched axes from the Middle Devonian of Scotland (Lang, 1925), and in *Hostimella hostimensis* from the Middle Devonian of Bohemia (Potonie and Bernard, 1904). A close comparison of the Victorian stems with some remains from the Devonian of the Northern Hemisphere has therefore been established.

The specimens from Warrentinna come within the range of size met with in the Victorian specimens named *Hostimella* sp., and the Y-shaped fragments are also in agreement (Lang and Cookson, 1930, figs. 1 and 4). None shows, however, the presence of an axillary 'bud,' the presence of which would provide a distinctive and satisfactory basis of comparison. The identification of the present material as cf. *Hostimella* sp. is given on the understanding that such a designation is purely descriptive and probably includes plant types of varied affinities.

A single, rather obscure specimen which differs from the above-described stems must be mentioned. It is shown magnified 3 diameters in fig. 7. In it the smooth axis, which is 1 mm. wide, shows a terminal subdivision into three more slender daughter-axes. Two of these are shown in the figure, the third, which lay beneath the rock on the left-hand side, having been exposed only after the subsequent removal of the covering-stone. During this operation portion of the middle branch came away, so that it is impossible to support, with an illustration, this more complete description of the specimen. The right-hand daughter-axis shows an early and equal division into two more slender branches, and there was some evidence that the middle axis branched in a similar manner. The third daughter-axis on the left-hand side (not shown in the figure) lies at a slightly lower level, and partially underlies the centrally-placed branch. It has not been possible to determine whether or not it also underwent bifurcation. The distal regions of the branch-system have not been preserved. Comparisons of such an incomplete specimen must be made cautiously, and can only be tentative. The only type with a terminal branch-system to which this specimen is at all similar is *Hedeia corymbosa*, a fructification described and known from the Upper Silurian at Alexandra, Victoria (Cookson, 1935, figs. 25 and 26). The main axis is more slender than in any known specimen of *H. corymbosa*, and since no information as to the terminations of its branches is available, this passing reference to a possible similarity of construction is sufficient.

CONCLUSION

No evidence has been obtained that the specimens from Warrentinna were parts of vascular plants, but their general appearance suggests that they were most probably portions of land plants. They have been compared with the smooth-branched axes of the type known as *Hostimella* sp., which are abundant constituents of many early Palaeozoic floras.

The question of the age of the Mathinna series is raised by the occurrence of these plant-remains. There are no records of land plants in the Ordovician. The oldest vascular plants at present known with any completeness are those from the Upper Silurian of Victoria, types of which have been used for comparison with the Tasmanian fragments. If the latter are vascular, as seems probable from their general appearance, and if the beds containing them are definitely proved by other means to be Ordovician, the interest in these plant-remains will be greatly increased. Mr. Nye, in his paper previously referred to, gives the age of the beds as Cambro-Ordovician, and draws attention to the lithological agreement with the Ordovician rocks of Victoria. He particularly mentions, however, the absence of graptolites and other fossils, by means of which an exact determination of age could be made.

The plant-containing sandstones at Warrentinna are also very similar lithologically to the plant-beds at Wood's Point and other localities in the Victorian Silurian, the irregular, conchoidal fracture being an additional point of agreement. The Silurian plant-bearing sandstones on the Victorian coast near Waratah Bay, with fragments which agree closely with those from Tasmania, are of particular interest in this connection. They are the nearest geographically, and are situated almost in a direct line north from the Tasmanian area. Although plants are not usually a satisfactory index of precise age, in this case, where the age appears to be a somewhat open question, they assume considerable importance. The presence of plant-remains in the Mathinna series, and their agreement with similar remains in Victorian Silurian rocks, renders it very probable that there is error in placing the beds as Cambro-Ordovician, and points to a higher level, presumably near the Silurian of Victoria.

The small fragment which shows some points of agreement with *Hedeia* from Victorian rocks is not sufficiently well defined to be used in support of a relationship between the Victorian and Tasmanian series. Its occurrence, however, increases the possibility that future work may result in the establishment of a more complete and comparable flora in the pre-Carboniferous rocks of Tasmania.

SUMMARY

1. Plant fragments have been described from rocks mapped as Cambro-Ordovician in North-Eastern Tasmania.
2. Some have been identified as cf. *Hostimella* sp.
3. A comparison with Silurian plants from Victoria is made.
4. The suggestion is put forward that the plant-bearing-series may later be proved to be of Silurian age.

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EXPLANATION OF PLATE XX

(All the figures are from untouched negatives. The figured specimens will be housed in the Mines Department, Hobart, Tasmania.)

Fig. 1. Cf. *Hostimella* sp.: An unbranched stem. (Nat. size.)
Fig. 2. } Cf. *Hostimella* sp.: Flattened incrustations, from each of which portion of
Fig. 3. } the core of matrix has been removed. (Nat. size.)
Fig. 4. A piece of sandstone showing plant-remains (cf. *Hostimella* sp.); one of these is branched and has a y-shaped form. (Nat. size.)
Fig. 5. Cf. *Hostimella* sp.: Two flattened incrustations, the right-hand specimen shows evidence of branching. (Nat. size.)
Fig. 6. Cf. *Hostimella* sp.: A small y-shaped fragment. (× 5.)
Fig. 7. *Incertae sedis*: A small branched axis. (Nat. size.)

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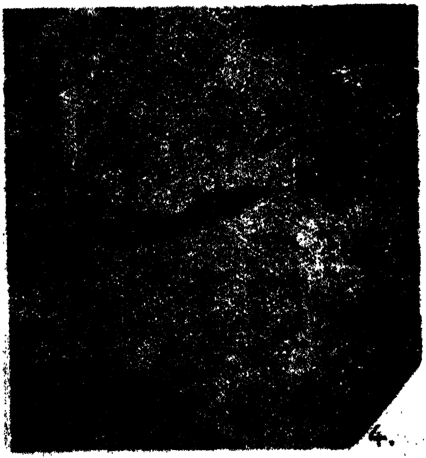
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PAP. & PROC. ROY. SOC. TASMANIA, 1936 (31ST MAY, 1937)

A Sealing Voyage to Bass Straits by the Schooner 'Brothers' in 1813

By

W. E. L. H. CROWTHER

(Read 9th November, 1936)

It is a remarkable fact that, in spite of the many voyages from Sydney Cove, Hobart Town, and Port Dalrymple to procure sealskins and sea-elephant oil, the only sources of information as to the incidents of these expeditions have been short reports in colonial newspapers and in official communications from Sydney to the Home Government. The logs kept by the masters of these small craft have almost completely disappeared. MacNab, in his outstanding work on the early whaling and sealing days of New Zealand, being unable to consult such sources in the libraries of Australia and New Zealand, made the long journey to New England for this purpose. Some years ago, by a fortunate chance, an old log, bound in kangaroo skin and kept in the well-known hand-writing of Captain James Kelly, came into my possession. In it were the proceedings of two voyages: first, that of the 'Brothers,' which is described hereafter, and secondly that of the 'Mary and Sally' to Macquarie Island to take sea-elephant oil and sealskins. The dates of these voyages were respectively the beginning and latter end of 1813. Although there is little in them that is sensational, yet the daily routine of the ship is of great interest, and considerable light is thrown on the primitive methods of sealing and unstinted killing on the islands where the seals congregated. It was the custom at this period for a ship to procure salt from Kangaroo Island for the preservation of the skins. Their wood and water were obtained from the nearest source to the seal rookery, whether island or mainland, and beyond these their needs were few. At the period of this voyage the sea-elephants of King's Island had been practically exterminated, and no reference to them is made in the ship's log. The fur seals had, however, recovered somewhat from the wholesale slaughter of their herds in days immediately following the discovery of the Bass Straits sealing grounds.

Captain Kelly, it will be seen, touched at several islands in the Straits for a period of more than four months, before he was able to return to Sydney Cove with some 7000 skins.

His ship, the schooner 'Brothers,' had been launched just over four years before, at Cockle Bay, Sydney, to sail on her first sailing voyage five months later, on 5th January, 1809. In the next three years she made at least three voyages to Port Dalrymple and King's Island. The opening pages of the ship's log is unfortunately missing, and the journal commences on 3rd January, 1813, on the coast of New South Wales. The fur seal, which was the object of this voyage, was about 6 feet in length, the female being a foot less. The adults had a coarse fur of grey to yellow-brown colour, the ventral surface being darker, and under this was a rich chestnut underfur which persisted through life.

The identity of this seal is uncertain. Scott and Lord claim that the common seal of the Bass Strait Islands is *Arctocephalus tasmanicus* Scott and Lord. Bones of *A. cinereus* (Péron) have been identified by Professor Wood Jones from the kitchen middens of the Tasmanian aborigines, and this species may have occurred on the islands in Kelly's time. A third species, *A. doriferus* Wood Jones, may also occur on the islands of the Bass Strait.

The colonial schooner 'Brothers' left Sydney Cove in the first week of January, 1813, to take seals in the Straits. Captain James Kelly had with him a crew of at least ten men, in addition to his ship-keeping party; as is shown by a later entry in his log, when he landed a shore party of that number at one of the sealing rocks.

After a stay of a day at Twofold Bay, the ship proceeded to the southward, but owing to a strong head wind at noon on the 5th came to in the entrance of Barmouth Creek, anchoring with the small bower in 9½ fathoms. On the next day the bay was cleared, and with the anchor stowed the boat was got on board and the voyage was continued. Five days later a stop was made under the Capashine Island (Flinders Island) in 20 fathoms. Two hours later, the anchor having commenced to drag, all sail was made, and with the loss of her buoy rope the ship stood to sea. The same afternoon a boat's crew was landed at the Stacks, and later returned with 12 skins. Rounding the north point of Van Diemen's Land, and standing to the south-west and west, Captain Kelly cruised for four days, evidently in the hope of discovering uncharted rocks or islets where seals might be found. Being unsuccessful, however, and the weather being bad, he bore up to King's Island, and the vessel stood in towards the land. In a hard squall the fore-gaff carried away, but at 8 p.m. she came to in Elephant Bay in 8 fathoms with the small bower. The same day a boat was sent ashore for a spar with which to make a new fore-gaff, and next morning six casks of water, with two boat-loads of wood, were taken on board.

Weighing at 6 p.m. the 'Brothers' came to under Counsellor Island[1] at 8 p.m. with the best bower in 3½ fathoms; the ship's boat, however, only obtained three skins, the local sealers having probably cleaned up the rookery.

After repairing the rigging, the voyage was resumed on 23rd January; and, standing to the north-east, Phillips Island was in sight next day. The following day, running into Western Port, the 'Brothers' came to under the island in 5 fathoms, and the ship's boat, with the shore party, was sent to the seal island. Returning next day with 304 skins, the party of ten made daily visits, taking successively 314, 104, and 17 skins.

On 31st January a move was made to the south-west, and at 5 p.m. Point Schank was 5 leagues distant. Next day Albatross Island was passed, and the same day the ship came to under Hunter's Island with the small bower in 7 fathoms, Three Hummock Island lying east by north 5 miles. After moving to another anchorage on the next day, two boats were sent to the Seal Rocks to kill seal. The boat having returned with 17 skins and evidently a good report of the prospects at the rookery, the vessel was got under sail, and anchored further up the south part of the bay, mooring with a small bower to the south'ard and the best bower to the north'ard. The small boat was taken on shore to be repaired. Three days later, having collected wood, and the repairs being completed, two boats were sent to the Seal Rock, and returned in 48 hours with 375 skins. The large boat had, however, been stoved in the operations. On Tuesday, 9th February, the crew were employed salting the skins and repairing the large boat whilst the schooner was unmoored and got under weigh, to be brought to an anchorage further to the northward, and so more conveniently to the Seal Rock. Standing to the northward, at 6 p.m. the next day she came to in a sandy bay in 6 fathoms, and was moored fore and aft. Two boats left at 8 a.m. for the Seal Rock to kill seal, taking with them 12 bags of salt. In three days a cargo of 612 skins was brought back, and the log notes the crew during the next day as stowing them in the hold and doing other necessary jobs. The large boat was soon again in trouble, and on Wednesday, 17th February, having returned with the small one and a cargo of 460 skins, part of the crew were employed in repairing her whilst others salted the skins. On the 20th hard gales were experienced, and the fore topmasts and yards had to be housed. Opportunity was taken to send the water-casks on shore to be filled. As the weather allowed, the boats were employed between the ship and the Seal Rock, on some days the surf not permitting them to land there. A succession of gales brought about a serious state of affairs, and the log of the 26th reads as follows: 'The day commences with hard gales at east and rain. 11 p.m. the vessel labouring very much, parted the small bower.' On the Seal Rock, where the boats were hauled up, 'The surf broke so high that it totally wrecked the large boat to pieces, and the small boat was barely being repairable to bring the people off the Rock.' The gales having taken up, three days later, at 4 p.m., the remains of the small boat returned with all the people. They had been obliged to put a square stem on her with sealskins. On the Rock 220 skins had been left, all salted. The small anchor was weighed with the boat's aid, and the cable was found to be gone in three places. This was spliced the next day, when the best bower was hove up and replaced by the small one; during this operation, however, a buoy rope was lost. Seven days are entered in the log as being spent principally on shore repairing the boat; wood and water were also got on board. Having got up the yards and topmasts preparatory to moving off, at 7 a.m. of 7th March, Kelly sailed with a light breeze, sending at 10 a.m. the boat to the Seal Rock with a load of salt. More salt was sent the next day, with firewood, the boat returning at sunset, when the ship stood to the westward. At daylight the south point of King's Island was bearing W. by N. distant 7 or 8 leagues. At 10 a.m. the boat was sent to the Black Rock, off Seal Point (south end of King's Island), to kill seal, and returned in two hours with 51 skins.

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[1] No island of this name is shown on the charts of the early navigators to Bass Strait, nor is it on Admiralty charts. The rocks off the north end of Sea Elephant Bay are, however, still known lately by this name. Close study of the log of the 'Brothers' also places it in this locality.

Remaining at sea during the night, at daylight the 'Brothers' stood in towards Seal Point, and moored in Chapman Bay in 12 fathoms. The boat visited Seal Point and procured 20 skins. The seals being so few in number, a move was made to the northward after taking in water, hoisting in the boat, and stowing the anchor. Tuesday, 16th March, commenced with moderate breezes at S.S.W. At 2 p.m. the schooner came to under Counsellor Island in 4 fathoms. The boat was sent to the river to look for the small boat belonging to Mr. Blaxcell, but returned at 7 p.m., not having been able to find it. The log reads: 'We supposing Robert Knight to have her at New Year's Islands by finding his directions all round the island.' Weighing at 8 a.m. with a light breeze, at 3 p.m. the 'Brothers' came to off Coomsces Bay in 13 fathoms, with the small bower. Seeing a smoke off Wig Point, the boat was sent on shore, and there found the small boat with Robert Knight, he having repaired her.

With this valuable addition to his equipment, Kelly at 1 p.m. weighed and sailed for New Year's Island, where he moored at 5 p.m. In the few remaining hours of daylight the boat obtained 120 skins from the islands. In spite of strong gales next day another 220 skins were obtained from the small island. The gales continuing, with smart showers of rain and hail, the following afternoon the crew remained on board salting skins, and the whaleboat was got on deck. The 21st and 22nd were also spent on board, shifting ballast out of the run to trim the vessel, taking down the yards and topmasts, and stowing skins. Another trip of the boat to the small island resulted in its return with 72 skins, and the next day, the 24th, at 2 p.m., the vessel unmoored, and at 8 p.m. came to off the north end of Counsellor Island in 8 fathoms. From here, at 10 a.m., another move was made to Elephant Bay, anchoring there at noon. Heavy gales were experienced during the following two days, but firewood was got off from the shore and a change made in the crew, whereby one, Bundle, was discharged at his own request, and Charles Peterson and Christian, residents on King's Island, were taken on board. At noon the vessel was again at sea, with her course S.S.E., towards her former anchorage under Hunter's Island. Landing a boat-load of salt on the passage, at 9 p.m. she came to off the west end of Three Hummock Island. After 11 hours sail was made to anchor at noon in the harbour (by which is meant, probably, the sheltered inlet from which they had worked Seal Rock in the earlier part of this voyage. The 30th March saw yet another shift, this time to the westward, where at 4 p.m., in a sandy bay, a stop was made, and the boat sent to Seal Rock with salt and provisions. For seven days the boat plyed between the rock and the vessel, bringing back 700 skins. The 7th April is noteworthy owing to the cable of the best bower parting, when the small bower was let go, and so the ship brought up. The boat on the same day brought back 240 skins. Considerable anchor drill was the routine for next day, when, having bent the small bower to the cable of the lost anchor, the vessel was warped further out of the bay with the kedge. The ship's large grindstone was lashed to the kedge, and both secured to the cable of the lost best bower. The latter anchor they were not able to secure owing to the buoy not watering. With these precautions the ship safely rode out next day, during which hard gales blew from the east. When the weather permitted the lost anchor was swept for, but without success. On the second day the boat was sent to the Rock, and returned with 292 skins. On Saturday, the 17th, giving up the search for the anchor, a large stone was brought off from the shore, and slung to the small anchor to moor the vessel.

For the next three weeks the crew were employed partly taking seals and partly on the ship salting and stowing down. On various days cargoes of 200, 250, 230, 350, 370 skins were taken on board. When, on 8th May, the boat came alongside with 810 skins and four bags of salt it was a sign that the end of sealing at the Rock was in sight, although another load the next day of 255 skins and 5 bags of salt was brought to the ship. After wooding and watering and getting up the yards and fore topmast, on the 13th the 'Brothers' stood out of the bay; but, the wind coming in from the westward, anchored in the same place for the night. A last call at the Rock after weighing enable the people sealing there to come on board with yet another 352 skins. Calling on the 16th to the north end of

Counsellor Island, the small boat was left at the river on King's Island[1] at 8 p.m. with the best bower in 3½ fathoms; the ship's boat, 18th May the sea log was resumed as the vessel set her course for Sydney Cove, where she arrived and moored on 31st May, 1813. The last entry in the log in Kelly's writing reads: 'N.B.—This ends the voyage of the schooner " Brothers," being 7090 seal skins.'

The files of the *Sydney Gazette* give interesting information as to the subsequent career of the schooner. After another voyage to Hobart Town, returning on 30th October, 1813, and one to Port Dalrymple, terminating in April, 1814, she cleared for New Zealand in June of the following year. In company with the 'Trial' a serious encounter took place with the Maoris at Trial Harbour (named after the vessel), near the River Thames.

These little ships had been trading for flax along the New Zealand coast, and returned to Trial Harbour to pick up flax the natives had promised to have ready for them. At noon on Sunday, 20th August, both vessels, in spite of having rigged boarding nets to prevent such an occurrence, were taken by the Maoris. The crews took refuge between decks, and from there and through the cabin skylight kept up a harassing fire with their muskets. Not accustomed to this type of warfare, and losing heavily, the Maoris quitted the decks. One of their number, however, who had had experienced with ships, cut the cables, and both the 'Brothers' and the 'Trial' went ashore. The crew of the latter, almost desperate, with a volley of seven muskets regained their own ship, and by using their swivels as well as the muskets drove off the natives from the 'Brothers.' Later the vessels were refloated and resumed their voyages. In this affray both ships lost several of their crew. A detailed account of the affair is given in the *Sydney Gazette* of 8th November, 1815.

Next year the 'Brothers' was lost on the Kent's Group, probably returning from Port Dalrymple with a cargo of wheat. Mr. Howell, the master, and ten men existed for ten weeks on the wheat that was washed on shore. Only one man of the crew was lost.

Captain Kelly had by this date permanently associated himself with Van Diemen's Land, his famous circumnavigation of the island having terminated early in 1816. Some details of his early seafaring as a sealer and whaler may be read in his evidence given before Mr. Commissioner Bigge.

ACKNOWLEDGEMENT.

I have to thank Miss Leeson, of the Mitchel Library, and Dr. F. Wood Jones for help in compiling this paper. Much detailed information as to sealing in these waters is contained in a thesis by the late L. C. Murray, B.A., presented to the University of Tasmania in 1927. This account has been of the greatest help to me.

PAP. & PROC. ROY. SOC. TASMANIA, 1936 (31ST MAY, 1937)

The Problem of the Tasmanian Aborigine

By

A. L. MESTON, M.A.

(Read 10th August, 1936)

On the evidence of a chalcedonic flake, W. H. Twelvetrees (1917) concluded that the Tasmanian aborigine had inhabited this island for, humanly speaking, a vast number of years. This flake was found by Mr. Richards while sluicing for tin at the old Doone Mine, north of Ringarooma River. The alluvial tin bed was overlain with drift from 10 to 20 feet deep, which had to be removed before the wash gravel was exposed. At the time of the discovery the sluicing nozzle was at the bottom of an excavation half a chain wide, 10 feet long, and 25 feet deep. Ten feet below the surface of the ground, and in consequence 15 feet above the bottom of the excavation where the hydraulic nozzle was being handled, a block of wash was detached from the cliff face. On the top of this block, *slightly* adherent to the gravel, Mr. Richards discovered the flake. It was shown to R. M. Johnston, who pronounced it as undoubtedly of human workmanship. I do not question its human origin, but in face of all the facts I cannot accept the view that it belonged to the alluvial gravel, which, according to Sir Edgeworth David's computation, dates back to the Riss glaciation, or about 100,000 years ago. The artifact as figured and exhibited bears a remarkable likeness, in respect of shape and retouch, to those we find to-day on the surface of the ground. It shows, as Sir Edgeworth David (1924) remarked, an 'extreme freshness,' that is there is a 'remarkable absence of weathering'; nor is it at all waterworn, although it was adherent to the alluvial wash, which was well waterworn. When picked up it broke into two pieces, one of which was thrown away. An examination of the plane of fracture revealed that there was a deposit of silica on the surface, and Twelvetrees stressed this as important evidence of its age as an artifact; for he inferred that the silica had been deposited in a fracture that had developed after the artifact was dropped. Such an inference is unfounded, because it is not uncommon to find recent artifacts in which there is a deposit of silica in a fracture, the aboriginal maker having made use of a pebble containing such a flaw. The hydraulic nozzle was used not only for disintegrating the alluvial wash, but also for getting rid of the overburden. Twenty-five feet below the surface of the ground the water was directed from the nozzle against the overburden, at this place 10 feet deep. When this was removed a face 15 feet high was left, the top of which was invisible from below. There seems to be no doubt that the stream of water washed the artifact from the surface, or from just below the surface, to the top of the alluvial, and it stuck there, not tightly, however, for it was only slightly adherent. When the water was turned off a subsequent examination revealed the flake, the peaty clay of the overburden providing an admirable adhesive. It is important to remember that no one could say exactly from what part of the face the detached mass came, and that no one saw the artifact on the block while it was *in situ*.

Dr. A. Lewis (1935) states that on the New Norfolk-road, near the 13th milestone, there is a mirnyong or midden that accumulated in the warm interglacial phase known in Tasmania as the Yolande-Margaret interglacial period, which he tentatively correlates with the Riss-Würm interglacial of the Northern Hemisphere. The date of this midden varies according to the authorities he quotes. It may have been formed as far back as 200,000 years ago, at the latest at least 100,000 years. His claim for such antiquity rests on three data: first, that the midden lies in a Yolande-Margaret terrace; secondly, that it is overlain by many feet of soil; and, thirdly, that the shells composing it belong to the open sea, and could not exist in the estuary in its present form. I will deal with these *scriatim*. That the terrace belongs to the Yolande-Margaret interglacial I do not dispute, but it has existed very much in its present form for many centuries past, and could have been used as a camping-ground 100 years ago just as well as 100,000 years. Since the white occupation of Tasmania, the ground has been cultivated, and the consequent shifting of the soil has caused shells on the roadside to be overlain by a few feet of earth; back from the road the shells are merely on the surface. Soil-creeping brought about by ploughing is a well-known phenomenon. Moreover, all the shells are remarkably fresh-looking. But it is on his last datum, that the mollusc shells found on the midden are such as could not exist except in the open sea, that almost the whole of his case depends. And here it falls to the ground. Not two chains away, on the banks of the river immediately below the midden, the very molluscs, *Modiolus confusus*, that he declares could not exist in the estuary in its present form, may be collected in countless thousands. The molluscs found on the midden, therefore, can, and do, exist in the estuary at the present day. From the zone of shells overlain by soil and from the surface of the midden I gathered a few worked flakes, in no way different from the flakes which may be picked up on the surface far and wide throughout Tasmania. This midden has every mark of recent origin, and is typical of the hundreds scattered throughout the island. The terrace faces the north, is composed of a sandy soil, and is protected from cold winds. A collector of aboriginal stone implements would inevitably look for a native camp at such a site. This midden does not, in my opinion, afford the slighest foundation for assuming that man has inhabited Tasmania for the long time, 100,000 years or more, that Dr. Lewis affirms.

During the last 30 or 40 years great interest has been aroused among physical anthropologists by the discovery of such primitive types as *Palaeanthropus* or Heidelberg man, *Pithecanthropus* or Java man, *Eoanthropus* or Piltdown man, and *Sinanthropus* or Peking man. They became extinct long before *Homo sapiens* was differentiated. Nor did Neanderthal man, who inhabited Europe during the Würm glaciation, belong to this species. The original home of *Homo sapiens* is not definitely known, but it is universally accepted that the species arose in either Africa or Central Asia.

The Aurignacians, whose culture had many affinities with the Tasmanian, were the first representatives of *Homo sapiens* to enter Europe. They crossed from Africa to Europe by a land bridge when the last or Würm glaciation was retreating. If we adopt M. C. Burkitt's (1933) computation of the date of the Würm glaciation based on the varve counting of de Geer, they entered less than 20,000 years ago. Elliott Smith, in his 'Human History,' dates it at 10,000 years ago. Of course there is nothing to prove that the Aurignacians invented the culture they possessed, but most authorities agree that their culture was not more than from twenty to forty thousand years old. The Aurignacians, the Tasmanian aborigines, and all peoples living to-day belong to the species *sapiens*. As no evidence of this species exists in Europe before the Aurignacians, it is clear that its dispersion was, in the geological sense, relatively recent. This goes far to disprove the idea that *Homo sapiens* existed in Tasmania more than 100,000 years ago.

The Tasmanian aborigine had the dark skin, flat nose, and wide nostril which are adapted to hot climates, but are disadvantageous in cold regions. He had also closely twisted hair and full, fleshy lips. In other words, he was a Negroid. The Negroids of the world may be divided into two main groups, widely separated geographically: the Negroes or Africans, and the Melanesians of Oceania. The Negroes occupy the whole of Africa south of the Sahara, and on the west coast extend to Morocco; the Melanesians occupy New Guinea, the Bismarck Archipelago, the Solomon Islands, New Caledonia, and Fiji. The Melanesians show much the same general characteristics as the Africa negro, but in a form suggesting admixture with other races. All this points to an original home for the Negroids, but its actual geographical situation remains a puzzle. It may have been somewhere in the tropical regions midway between Africa and Papua, but the fact that the distinctive negro characteristics are more obtrusive and constant in Africa tends to suggest that the Negroids originated in that continent. As these negroids migrated towards the east there would be some admixture with the peoples with whom they came into contact. This would weaken some of the original distinctive features. Anthropologists have frequently commented on the existence of individuals among the negroids of the Solomon Islands and elsewhere whom they could not distinguish from Australians. This probably indicates an intermingling with Australians. Similar interminglings must have occurred throughout the centuries during which the migration took place.

When we come to ask how the Tasmanians reached Tasmania we find considerable diversity of opinion. The oldest theory of all is that the Tasmanians entered from Australia by a land-bridge. But, as Dr. Lewis (1935) points out, such a land-bridge could have existed only during Malannan times—that is, well over 100,000 years ago. There is no evidence that *Homo sapiens* had yet evolved, and it is quite certain that no culture equivalent to that reached by the Tasmanian had come into existence. These facts make it impossible to accept the land-bridge theory.

Of recent years another theory has arisen of which Professor Wood Jones (1935a) is the chief exponent. The adherents to this theory affirm that Tasmania has been peopled direct from New Caledonia, an island lying between 20° 1′ S. and 22° 26′ S., and more than 1700 miles distant. Either the New Caledonians deliberately sailed away into the unknown in search of land, or a boat-load, containing at least one young woman, was blown away in a storm, and eventually, after suffering dreadful hardships, was washed ashore on the Tasmanian coast. There are many difficulties in the way of accepting this theory. In the first place, the Melanesians, unlike the Polynesians, were not sea rovers, and did not make long ocean voyages. Their distribution is confined to island chains. This in itself is enough to compel us to reject the idea that Tasmania was peopled by them as the result of a deliberate voyage far out into the distant unknown. They could reach New Caledonia by making use of a chain of islands, but no island chain exists, or has existed within human experience, between New Caledonia and Tasmania. With the exception of two small islands, Lord Howe Island and Norfolk Island, mere specks on the ocean's bosom, a vast unbroken expanse of sea rolls between the two. There remains the alternative that a boatload was cast ashore on Tasmania as the result of a storm or a series of storms, and that there were survivors. This is so wildly improbable and fantastic as to be regarded as impossible. Apart from the great time involved in drifting 1700 miles in a direct line, in an open boat, with a blazing sun overhead, and a shortage of food and water, there is another aspect. New Caledonia is situated in a region where the south-east trades are constant throughout the year. This wind is so strong that, although Tasman was in a well-found ship, he could not make his way through Torres Strait against it. Cook nearly suffered shipwreck on the Great Barrier Reef because the great waves raised by this wind swept the ' Endeavour ' towards it. Had he not found an opening in the nick of time there is nothing surer than that the ship would have been dashed to pieces. The south-east trades blow from New Caledonia towards the coast of Queensland. To reach Tasmania, therefore, the New Caledonians must voyage against a constant wind and high sea.

In further proof that Tasmania was peopled by a few voyagers from New Caledonia the paucity of numbers of the Tasmanians is cited. It is assumed that if more than a canoe-load had reached the island, there would have been many more natives living there when the first white settlers arrived. Opinions differ as to the number. Backhouse estimated that there had never been more than 1000; Robinson put the number as between 6000 and 8000; Milligan said 2000. A comparison with the number of the aboriginal inhabitants of Victoria before white settlement is illuminating. Wood-Jones (1935b) estimated that at the foundation of Victoria about 6000 aborigines lived there. The greatest estimate of their number is that of E. S. Parker, 7500; the smallest that of George Augustus Robinson, 5000. Robinson worked on the basis of the distribution of one aborigine to each 16 square miles of country. If Victoria, with its less rigorous climate, greater area, and great plains stocked with game, could maintain an aboriginal population of but 6000, Tasmania could not maintain nearly so many. If we adopt Robinson's basis of computation, the aboriginal population would be fewer than 2000. And this is the estimate one arrives at from the various accounts of numbers observed at different places. A small population, however, by no means necessarily implies that the first settlers were few. Density of population is strictly limited by the food supply. Tasmania had no edible fruits, berries, or nuts worth mentioning, no edible roots of much account, and no grain plants to offer the aborigines. The cold of the central plateau in winter drove the natives to the sea-coast. The wet forests of the west coast and the great extent of barren, rugged country precluded habitation then as it does now. We have only to note what little use we can make of more than half Tasmania to realize that it had little to offer a race of food-gatherers. The natives had to struggle hard for a meagre existence. Geographic control has always been a powerful agent in restricting population. At the advent of the white race the native population was stationary, for saturation point, so to speak, had been reached.

If the aboriginal voyagers were able to surmount the difficulties of adverse winds, seas, and currents, it is obvious to all that such a voyage demands a boat much more substantial than that which the

Tasmanians possessed when discovered by white races. The upholders of this theory surmise that the descendants of the castaways forgot how to build substantial boats. There is no doubt that such degeneration does actually take place. Dr. Codrington (1891) states that in the Torres Islands (not to be confused with the islands of Torres Straits) the canoe-makers had died out, and the islanders acquiesced in the loss of what had proved of great use to them. The inhabitants of Mangareva are also credited with having lost the art of canoe-making. But it is difficult to believe that the Tasmanians forgot how to construct the substantial sea-going canoe, yet remembered perfectly how to construct that type of canoe which their ancestors had made thousands of years before (see Meston, 1936, p. 159).

The Tasmanian canoe was not suited for long ocean voyages. It is probable, therefore, that the Tasmanians came to Oceania by way of the chain of islands known as the East Indies. Even supposing, and there is no ground for such an assumption, that many of the islands now existing were joined to Asia and Australia when the migration took place, there was never a time in human history when there was continuous land between the two continents. The East Indies are divided by a sea passage known as Wallace's Line, which has existed for so long a period that the indigenous mammalia on the opposite sides of it are as widely divergent as in any two parts of the world. This line separates Borneo from Celebes, and Bali from Lombok. Whatever land-bridges man had, he must always have had to cross the 15 miles of sea between Bali and Lombok or the wider Macassar Strait between Borneo and Celebes.

Professor Huxley (1870) named as the nearest living representative of the Tasmanians 'the inhabitants of New Caledonia and those of the islands of Torres Straits and New Guinea.' Professor Wood Jones (1935a) makes use of Huxley's statement, but omits the reference to the islands of Torres Strait and New Guinea. Surely it is strange, if, having reached the islands of Torres Straits, the negroid migrants did not reach Australia, which lay in sight, although they proceeded east and south by way of the New Hebrides to New Caledonia. The most reasonable explanation is that these eastern negroids crossed to the mainland of Australia and settled there. They would in course of time, without any external drive, gradually move southwards. This is supported by the high percentage of skulls in the southern half of Australia which show Tasmanoid characteristics. Professor Wood Jones (1935a) explains them as a result of an intermingling of Tasmanians with Australians since the coming of the English. While it is true that Tasmanian aborigines did cross to Victoria after white settlement, they were so few in number and their opportunity for intercourse with the mainland native was so little, that such an explanation is totally inadequate. Nor will it suffice to account for the number of skulls with marked Tasmanoid characteristics which have been found in Queensland.

The main objection that Professor Wood Jones has to the theory that the Tasmanians came by way of Australia is that they neither learned to domesticate the dingo nor to assimilate any of the main cultural features of the Australians. He assumes that the Tasmanians were driven out by the invading Australians, and in their flight reached Tasmania. But it is equally valid to consider that the Tasmanians formed the advance guard of the negroids, and voluntarily migrated across Bass Strait without coming into contact with the Australians, reaching Tasmania in a way similar to that whereby their negroid relatives reached the New Hebrides and New Caledonia. Once Australia was reached there would be a gradual move southwards along the coast until Bass Strait itself was reached.

The supporters of the land-bridge theory raise two objections to such a crossing. First, because, they say, the Tasmanians had no vessels capable of crossing Bass Strait; and, secondly, that it is difficult to imagine a primitive people setting out for a land which lay over the horizon, and of the existence of which they must have been entirely ignorant.

Let us examine these objections. That the Tasmanians did not possess seaworthy craft is quite erroneous. Primitive though their bark-bundle canoes were, they voyaged regularly to the islands which fringe our coasts, crossing not only sheltered waterways, but facing the great swell which perpetually rolls in from the Southern Ocean, or the steep ugly seas and racing tides which guard the islands at the western end of Bass Strait. Nor did they always wait for calm weather. They have been seen, for instance, to visit the Mattsuyker Islands, off our southern coast, in the midst of a storm.

An examination of the Admiralty Chart 1695A shows that the second objection is based on a geographical misconception. A string of islands, none of which is 25 miles distant from the next, stretches all the way from Wilson's Promontory to the mainland of Tasmania. In crossing Bass Strait by this route one is never out of sight of land, and land with a bold outline; so that the Tasmanian aborigines by using this route would not be setting out for a land which lay over the horizon beyond their ken.

From Deal Island, 35 miles north-west of Flinders Island, both Wilson's Promotory and Flinders Island are clearly seen, as well as the intermediate islands, which form, as it were, giant steppingstones. On Hogan Island and on Deal Island there are abundant and permanent supplies of fresh water. There is no need to say that this is true of Flinders, Cape Barren, and Clarke Islands.

From all this it follows that the aborigines could voyage to Tasmania by way of the Hogans and Kent Group without crossing a sea-lane wider than 25 miles, and with permanent fresh water at no stage of the journey at a greater distance than 35 miles. Shellfish, seals, and mutton-birds, and on the larger islands wallabies, wombats, and opossums, would provide them with a bountiful food supply. Such a voyage would offer little difficulty. Their ancestors had to cross much wider sea-lanes on their migration; and longer voyages in canoes quite as primitive are made elsewhere in the world. Sollas (1915), for example, tells us that in their primitive canoes or balsas the Seri Indians cross the Gulf of California, a distance of from 50 to 100 miles. And it must be remembered that the total distance from Wilson's Promotory to Flinders is less than 90 miles, with two excellent stopping-places.

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The Royal Society of Tasmania

Annual Report

1936

The annual meeting was held at the Society's Rooms, Tasmanian Museum, Hobart, on the 8th March, 1936.

The following were elected as members of the Council for 1936:—Mr. S. Angel, Mr. H. Allport, Mr. W. H. Clemes, Dr. W. L. Crowther, Mr. V. V. Hickman, Dr. A. N. Lewis, Hon. L. M. Shoobridge, Mr. E. E. Unwin, Mr. F. E. Ward.

His Excellency the Governor nominated the following members as Vice-Presidents:—Mr. F. E. Ward and Mr. V. V. Hickman.

The Council at its first meeting made the following appointments:—

Chairman of the Council: Mr. W. H. Clemes.
Secretary: Dr. Joseph Pearson.
Hon. Treasurer: Mr. S. Angel.
Standing Committee: Mr. Unwin, Dr. Lewis, and Dr. Pearson.

Representatives of the Society on the Board of Trustees of the Tasmanian Museum and Botanical Gardens:—Mr. W. H. Clemes, Dr. W. L. Crowther, Dr. A. N. Lewis, Mr. S. Angel, Mr. E. E. Unwin, Hon. L. M. Shoobridge.

Nine meetings have been held during the year, and, in addition to the lectures delivered, scientific papers of considerable value and interest were submitted for publication.

(See abstract of meetings for abstracts of lectures, papers, &c.)

The Society's library still continues to be of service to members and others desiring scientific and historical information. During the year 479 volumes have been added, bringing the total up to 18,733.

Mrs. Clive Lord continues to act as Assistant Librarian, and under her supervision the library is gradually being reorganized, and a distinct improvement has already manifested itself.

The Government has again assisted with the printing of the Papers and Proceedings, and this concession is greatly appreciated by the Council.

The membership for the year, compared with that of 1935, is as follows:—

	1935.	1936.
Honorary members	4	3
Corresponding members	4	3
Life members	7	7
Ordinary members	229	223
	244	238

During the year 11 names were removed from the membership owing to deaths, resignations, &c., and five new members were added.

The Council regrets to have to record that the following members have died during the year:—

Mr. R. W. Giblin.
Mr. L. Rodway.

The Late Leonard Rodway, C.M.G.

The Council wishes to make special mention of the late Mr. Leonard Rodway, who died on 9th March, 1936, in his eighty-third year. Mr. Rodway was the son of Henry Barrow Rodway, of Torquay, Devon, England, and was born in Torquay on 5th October, 1853. He was educated in Birmingham, and later served full time on the Officers' Training Ship 'Worcester,' and passed out with a double first-class extra certificate, a position very seldom obtained; he also passed under steam for the Royal Navy, and was three years midshipman in the George Marshall service.

Having left the sea and gained the Licentiateship of the Royal College of Surgeons of London, Mr. Rodway arrived in Tasmania in 1880, and joined the Royal Society of Tasmania four years later. He had always been a prominent member, and had been a member of the Council since 1911, at one time holding the position of Chairman. For some years he was Senior Vice-President of the Society, and was a trustee of the Tasmanian Museum and Art Gallery and of the Botanical Gardens. He was appointed Honorary Government Botanist by Sir Edward Braddon in 1896, a position he had held ever since, and it was in the field of botany that Mr. Rodway had performed such outstanding work on behalf of the State; but he had done meritorious work of a civic and scientific nature generally. For

THE LATE LEONARD RODWAY, C.M.G.

instance, he was for many years a member and sometime Vice-Chairman of the Technical School, and for thirty odd years was on the staff of the General Hospital as Honorary Dentist. He performed splendid work for many years as a member of the Domain Improvement Committee; he was Chairman of the National Park Board, and for many years Chairman of the Tasmanian Field Naturalists' Club; he was President of the Sandy Bay Rowing Club and the Tasmanian Branch of the Royal Life-Saving Society, and was prominent in the University Extension Lectures and the Workers' Educational Association. He was a member of the Scenery Preservation Board and also Advisory Officer to the Forestry Department, and for some years Lecturer in Botany to the University.

Mr. Rodway made notable researches in the botany of Tasmania, and, in addition to numerous papers contributed to the Papers and Proceedings of this Society, he found time to compile a comprehensive work on 'The Flora of Tasmania,' as well as smaller handbooks on 'The Wild Flowers of Tasmania,' and a complete description of the Mosses and Hepatics of the State.

Mr. Rodway was awarded the Clarke Memorial Medal of the Royal Society of New South Wales and the medal of the Royal Society of Tasmania for his botanical researches. In 1917 he was awarded the C.M.G. by His Majesty the King, in recognition of his services to the State and to botanical science.

At the monthly meeting of the Society held on 6th April, 1936, the following resolution, proposed by Dr. A. N. Lewis, and seconded by Mr. W. H. Clemes, was carried:—

> 'That the Royal Society place on record its appreciation of the outstanding work done by the late Mr. Leonard Rodway, C.M.G., and his services to the Society and to the State; and that a letter of condolence be sent to Mrs. Rodway and to the family of the late Mr. Rodway.'

At the monthly meeting of the Society held on 11th May, 1936, it was announced that the Trustees of the Tasmanian Museum and Art Gallery had decided to make a public appeal for funds to provide a memorial to the late Mr. Rodway. The Royal Society of Tasmania agreed to co-operate with the Trustees in this matter. Subsequently a public meeting was called on 22nd July, 1936, when it was decided to issue an appeal to the public for subscriptions in order to establish a memorial to the late Leonard Rodway, and it was agreed that the money so collected should be expended as follows:—

(1) A portrait of Mr. Rodway to be painted by his daughter, Mrs. Moore (Florence Rodway).

(2) The balance to be applied to the purchase of botanical books for the Royal Society's library, such books to be suitably inscribed to indicate that they form part of the Rodway Memorial.

In response to the public appeal the sum of £93 14s. 6d. was collected.

The Council has pleasure in announcing that Mrs. Leonard Rodway has presented her husband's botanical library to the Royal Society. In accepting the gift the Council, after consulting the Trustees of the Tasmanian Museum and Art Gallery, decided to provide room for this library in the Museum herbarium, where it would be at the disposal of botanical students. It was further decided that the library shall be known as 'The Rodway Memorial Library,' and so labelled.

The family of the late Leonard Rodway presented to the Society the Clarke Memorial Medal of the Royal Society of New South Wales and also the medal of the Royal Society of Tasmania. Dr. Rodway, eldest son of the late Leonard Rodway, offered to lend his father's C.M.G. decoration. These offers were gratefully accepted, and it was decided that the medals should be placed in a suitable case, and displayed beneath the portrait of Leonard Rodway, which, when completed, will be hung in the Art Gallery.

Aboriginal Rock Carvings at Mount Cameron West

Concern has been expressed regarding the deterioration of these rock carvings, due to weathering and other causes, and it was suggested that steps should be taken either (*a*) to remove samples of the carvings to a safe place, or (*b*) to have casts made which could be placed in the Tasmanian Museum and other museums.

The Council decided to invite Mr. N. B. Tindale, Ethnologist to the South Australian Museum, to visit Mount Cameron West, and report to it as to what, in his opinion, would be the best procedure. With this end in view the Government was requested to make a grant towards the cost of bringing Mr. Tindale to Tasmania, and the Government agreed to make a grant of £30 for this purpose. Ultimately this was increased to £50 15s. 10d.

Mr. Tindale visited Tasmania in April, and, with the Secretary (Dr. Pearson) and Mr. A. L. Meston, visited the rock carvings at Mount Cameron West. Later Mr. Tindale presented a report, in which he recommended that immediate steps be taken to remove about seven of each of the large boulders to the Tasmanian Museum, and that the remaining inscriptions should be, if possible, protected from further weathering by a special treatment of the surface of the rock.

On his way back from Mount Cameron West Mr. Tindale inspected the rock carvings at Devonport, and it was his opinion that one or two outstanding examples of these should be removed to safe keeping in a museum, and that in addition plaster casts of all the other examples should be prepared for preservation in the National Collection at the Tasmanian Museum.

As the rock carvings at Mount Cameron West are situated on the property of the V.D.L. Company, the Council of the Society requested the Company to give the Council powers to carry out Mr. Tindale's recommendation. The Council is glad to report that the V.D.L. Company, through Mr. A. K. McGaw, C.M.G., has agreed to permit of the removal of any specimens which may be necessary in accordance with Mr. Tindale's report. The only thing that now remains to be done is to approach the Government, to obtain from it financial assistance in order to carry out the scheme which Mr. Tindale proposed. This will be done during the year 1937.

18TH JUNE, 1936

A meeting was held in the Society's Rooms on this date, the President, His Excellency the Governor, presiding.

The following member was elected:—Mr. H. H. Pearce.

Professor F. E. Lloyd, Professor of Botany in the McGill University, Montreal, gave a lecture entitled 'The Carnivorous Plants of the World,' of which the following is an abstract:—

> The Professor, who has made an extensive study of carnivorous plants, stated that Australia was of particular interest in relation to them, as in the Commonwealth, he thought, there were more kinds of these plants than in any other country in the world. He expressed himself a firm believer in the old Chinese proverb: 'A hundred hearings is not as good as one seeing.' Professor Lloyd illustrated his remarks with a series of lantern slides, in which the main features of many of the 450 kinds of plants that capture and digest insects and other such creatures were shown.
>
> The latter portion of the lecture comprised motion pictures of several of the carnivorous plants in actual action, and of the principles on which the main species operate.

13TH JULY, 1936

A meeting was held in the Society's Rooms on this date, the President, His Excellency the Governor, presiding.

Dr. W. Arundel Orchard gave an interesting lecture entitled 'The Evolution of Keyboard Instruments and Their Music,' of which the following is an abstract:—

> Dr. Orchard told how in 1885 the small clay model of an organ with pipes and a keyboard had been discovered among ruins of ancient Carthage. The instrument was made by the Egyptian Ctesipius, and was dated about 320 B.C. The organ appeared to have been used in the church for the first time in Spain, about the fifth century, but without any knowledge of the ancient instrument. It was merely a set of pipes with a slide under each pipe. The keys, about 2 inches wide and 18 inches long, gradually became smaller.
>
> It was not until the thirteenth and fourteenth centuries that one heard of a small keyboard adapted to strings. The first instrument of this type seemed to be the clavichord, the wires whereof were pressed by a brass tangent acted on by a key. The sound was very quiet. One beauty was that as long as one kept a finger on the key the sound continued, so that one could get a "Bebung" or vibrato. Hence the partiality of John Sebastian Bach for the instrument. Many of his famous fugues sounded much better on it than on the modern piano.
>
> The instrument, called in English the virginal and in Italian the spinet, was played in another way. At the end of the key within the instrument was an upright piece of wood known as a jack, tipped with a piece of leather or a quill. The harpsichord had on a larger scale the same action as the virginal. Dr. Orchard gave examples of harpsichord music played by members of the Dolmetsch family, and showed how popular the instruments were in the sixteenth, seventeenth, and eighteenth centuries. Dr. Orchard spoke of the great makers, beginning with Hans Ruckers, of Antwept, and Tschudi (forerunner of Broadwoods), who made magnificent harpsichords.

10TH AUGUST, 1936

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

Mr. A. L. Meston gave an interesting lecture entitled 'The Problem of the Tasmanian Aborigine.' (See this volume, p. 85.)

7TH SEPTEMBER, 1936

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

The first Clive Lord Memorial Lecture was delivered by Professor L. F. Giblin, D.S.O., M.A., Ritchie Professor of Economics, University of Melbourne. His Excellency the Governor presided, and before the lecture presented the Clive Lord Memorial Medal to Professor Giblin.

Professor Giblin took as his subject a general survey of developments of Tasmanian economy, its present position and prospect. He closely analysed the relative growth of population in Tasmania and the mainland of Australia, with special reference to the industries occupying working groups of various classifications, the indication being that Australia's rate of advance was consistently more rapid than that of Tasmania. As regards occupational activity, Tasmania showed a make-up of population different from the Australian average. It was computed that Tasmania's annual income was about 14 millions, which was offset by the heavy burden of interest on public debt as well as the interest on outside money invested in industrial undertakings. On the other hand, the State benefited to the extent of one million pounds received from the Commonwealth. In 1934-35 Tasmania's imports exceeded her exports by nearly £300,000. The State could not indefinitely go on living on its debts. It was noteworthy that over 90 per cent. of her exports were interstate. Tasmania, therefore, was most inter-dependent of the States of Australia, and, despite her insular position, was more organically a part of Australia than any other State. It followed that prosperity and progress for Tasmania was very closely bound up with the prosperity of Australia as a whole. A view of the State's chief products suggested the same conclusion. There was very little scope for expansion in the wool trade, and, as regards metals, new mining fields of importance were still possible but not very probable.

Tasmania's other important overseas export was apples, of which there was a sorry tale to tell. Over-production had been disastrous, and it would pay Tasmania better to restrict her exports of apples. Everything pointed to the fact that the prosperity of Tasmania was intimately bound up with that of Australia as a whole, and the conclusion was that Tasmania must link itself with Australian development. The lecturer then went on to examine the trade position of Australia as a whole from this point of view.

In conclusion, the lecturer stated that a general increase of world's trade was essential to Australia's industrial development, and there was hope of this. Tasmania should grasp the chance that would present itself in Australia's increased development, but more intelligently organized methods were definitely called for in this direction. Tasmania, therefore, should set herself to study every possibility of increasing her mainland market, and should shape her industries to share the results of Australia's domestic expansion.

12TH OCTOBER, 1936

A meeting was held in the Society's Rooms, Mr. F. E. Ward, in the absence of His Excellency the Governor, presiding.

The following member was elected:—Hon. E. Dwyer-Gray.

The following papers, submitted for the 1936 Papers and Proceedings, were tabled, and referred to the Standing Committee:—

'The Occurrence of Fossil Plants at Warrentinna, Tasmania,' by Isabel C. Cookson, D.Sc.

'Australian Leaf-hoppers (Jassoidea, Homoptera), Part 4,' by J. W. Evans, M.A., F.R.E.S.

'Australian Leaf-hoppers (Jassoidea, Homoptera), Part 5,' by J. W. Evans, M.A., F.R.E.S.

Mr. H. T. Parker delivered a lecture entitled 'The Examiners on the Defensive,' of which the following is an abstract:—

Mr. Parker said examinations were typically authoritarian. The autocracy of the examiner, founded on prestige, probably arose from respect for the exactitude which attached to empirical-mathematical facts. A report was published towards the end of last year by an English committee of inquiry under the chairmanship of Sir Michael Sadler, and including such outstanding educationists as Dr. P. B. Ballard, Dr. C. Spearman, Sir Percy Nunn, and Sir Philip Hartog. The committee gathered actual examination scripts, and had them examined by sets of recognized examiners. They then made comparisons of the results obtained. The marks allotted by examiners for any one paper showed wide discrepancies. When an examiner marked a paper for a second time it was not unusual for him to change his own verdict. But there was a more fundamental question to be faced. How did that which examinations purported to measure agree with the ideal or the actual product of education? Quite commonly they spoke of teachers preparing pupils for examinations, yet every educator knew that such a process was a debasement of the function of the teacher. The examination did not set out to test the result of teaching, but only that examinable part of it which was represented by certain memory and (possibly) intellectual processes. The chief charge against the examiner was that he had undertaken functions which he could by no possibility discharge. These functions had been thrust upon him. But in attempting to discharge them he had essayed the impossible, and so had laid himself open to challenge. Education was concerned with the development of the whole powers of the individual, artistic, intellectual, and social. With the intellectual development alone had the examination any considerable place, and with that, only in respect of what were recognized as its responsive or reactive aspects.

Some points on the other side were that the examiner had no standards to guide him. He was compelled to contrive his own, and was liable to differ from other examiners, and also at times to falter in his own. The limits of his task had not been prescribed. He examined within a certain syllabus, and in self-defence was reduced to observance of the mere letter of a course of instruction. The examiner was forced into a false position by the magnification of his assessment to the relative neglect of other educational outcomes. The examiner was untrained. It was enough for one to be eminent in his profession to be considered eligible as an examiner.

9TH NOVEMBER, 1936

A meeting was held in the Society's Rooms, Mr. V. V. Hickman presiding in the absence of His Excellency the Governor.

The following member was elected:—Mr. J. Burgess Watt.

Dr. W. L. Crowther delivered a lecture entitled 'Sealing in Bass Strait.' (See this volume, p. 79.)

Northern Branch

Annual Report, 1936

The activities of the Northern Branch during 1936 comprised: Annual meeting, followed by public lecture; four monthly meetings (two of them public lectures); six Council meetings.

All meetings were held at the Public Library, Launceston.

12TH MAY, 1936

Annual Meeting

Mr. A. L. Meston presided. The following officials were elected for 1936:—

President: Mr. A. L. Meston.

Council: The President, Hon. Tasman Shields, Mr. W. R. Rolph, Mr. R. S. Padman, Mr. F. Heyward, Mr. D. V. Allen, Mr. J. E. Heritage, Mr. F. Smithies, Mr. J. R. Forward, and the Secretary.

Hon. Secretary: Mr. E. O. G. Scott.

Hon. Auditor: Mr. R. S. Padman.

The statement of accounts, which disclosed a credit balance of £28, was read and adopted.

Public Lecture

The annual meeting was followed at 8 p.m. by a public lecture, 'Heredity, Genetics, and Eugenics,' by Dr. Joseph Pearson, who was introduced by the President. There was an attendance of about 150.

23RD JUNE, 1936

The President, Mr. A. L. Meston, presided.

The meeting took the form of a public lecture, 'The Carnivorous Plants of the World,' by Professor Francis E. Lloyd, McGill University, Montreal. There was an attendance of about 150.

20TH JULY, 1936

The President, Mr. A. L. Meston, presided.

The meeting took the form of a public lecture, 'Hydro-Electric Development in Tasmania,' by Mr. W. E. Maclean, Hydro-Electric Commissioner. There was an attendance of about 200.

24TH AUGUST, 1936

The President, Mr. A. L. Meston, presided.

Illustrated lecture: 'The Problem of the Tasmanian Aborigine.'

Discussion: Messrs. W. Calver, W. R. Rolph, D. V. Allen, and E. Scott took part in the discussion following the lecture.

28TH SEPTEMBER, 1936

The President, Mr. A. L. Meston, presided.

Papers:

(*a*) 'The Problem of the Tasmanian Aborigine,' by A. L. Meston, M.A.
(*b*) 'Observations on Some Tasmanian Fishes, Part IV.,' by E. O. G. Scott, B.Sc.
(*c*) 'Observations on Fishes of the Family Galaxiidae, Part II.,' by E. O. G. Scott, B.Sc.

Exhibits: The President exhibited, and gave a short account of, (*a*) a Tasmanian aboriginal drinking-cup, (*b*) a series of Tasmanian pebble-choppers.

COUNCIL MEETINGS

Meetings of the Council were held on 22nd April, 28th May, 10th July, 30th July, 21st September, 10th December.

Walter E. Shimmins, Government Printer, Tasmania.

PAPERS & PROCEEDINGS

OF

THE ROYAL SOCIETY OF TASMANIA

FOR THE YEAR

1937

Edited by

J. W. EVANS, M.A. (Cantab.), F.R.E.S.

and

JOSEPH PEARSON, D.Sc. (Manc.), D.Sc. (Liverpool), F.R.S.E., F.L.S.

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The Royal Society of Tasmania

Papers and Proceedings, 1937

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PAP. & PROC. ROY. SOC. TASMANIA, 1937 (20TH MAY, 1938)

The Morphology of the Head of Homoptera

By

J. W. EVANS, M.A., F.R.E.S.

(Read 8th November, 1937)

Although a great deal of attention, on the part of several workers, has been devoted [illegible] a study of the head structure of Hemiptera, the interpretatior [illegible]ernal [illegible] presents one of the most controversial ques- [illegible] ext[illegible] [illegible]natomy, uncertainty still exists as to the [illegible]mologies of [illegible]arious sclerites. Hence in taxonomic papers the same part of [illegible] may be named differently according to the views held by the res[illegible] authors.

The present work has been made p[illegible] by the recent discovery of abundant material of *Hemiodoecus fide[illegible]* [illegible]ns, a representative of the Peloridiidae, which is undoubtedly the most a[illegible] hemipterous family still in existence.

PELORIDIIDAE

The Peloridiidae, which comprise the whole of the series Coleorrhyncha, have been fully discussed by Myers and China (1929), China (1932), and Helmsing and China (1937), and, as pointed out by Helmsing and China, 'may well be descended in an almost direct line from proto-hemipterous ancestors'.

The first interpretation of the head-structure of an insect belonging to this family was given by Myers and China, and was based on an adult specimen of *Hemiodoecus leai* China. The sutures that limit the sclerites of the head, though distinct with the nymphal instars, are unrecognisable in the adult head, hence these authors made certain errors in their interpretation. The present author, in an earlier paper (Evans, 1937, *b*), also incorrectly interpreted part of the head of a peloridiid, since he based his interpretation on a specimen mounted on a slide, without previous dissection.

Figure 1 represents the head of a pre-imaginal nymph of *Hemiodoecus fidelis* Evans. Between the eyes lies the large vertex, which, owing to the opisthognathous nature of the head, is entirely ventral in position, and which is divided medially by the coronal suture. This branches anteriorly as the epicranial suture, which lies along the posterior margin of the frons. On either side of the frons is the frontal suture, and separating the frons from the clypeus, the epistomal suture. From the point of junction of the epistomal suture with the frontal suture, on each side of the head, arise the sub-genal sutures. The genae bear the antennae, and are separated from the vertex on each side by an ill-defined suture that does not continue as far as the eyes.

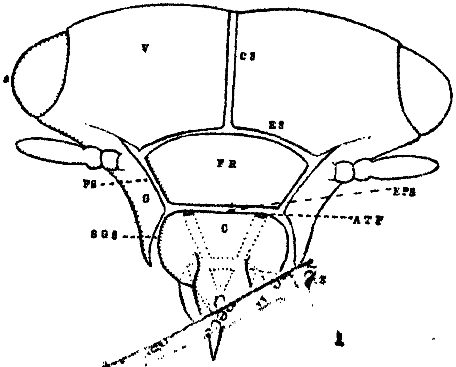

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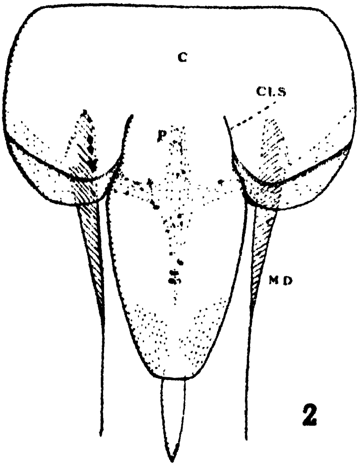
Fig. 1. [illegible] of *Hemiodoecus fidelis* in facial aspect.
v., vertex; *cs.*, coronal suture; *es.*, epicranial suture; *fr.*, frons; *fs.*, frontal suture; *g.*, gena; *eps.*, epistomal suture; *atp.*, anterior tentorial pit; *sgs.*, sub-genal suture; *c.*, clypeus; *cls.*, clypeal suture; *mp.*, maxillary plate.

It will be noticed that, apart from the epistomal and sub-genal sutures, three sutures have been named separately, instead of two as is usual. Myers (1928), under the term 'epicranial suture', includes doth the coronal and epicranial sutures, whilst Snodgrass (1935) retains the present coronal suture, but includes both the epicranial and frontal sutures under the term 'frontal suture'.

The clypeus is divided into two parts (Fig. 2), an anterior part from the ventral wall of which arises the labrum, known usually as the labrum-epipharynx, and a posterior part which bears antero-medially the impressions of the dilator muscles of the sucking-pump, and extends laterally on either side as swollen lobes (the 'frontal lobes' of Myers and China). These lobes are recurved antero-laterally, and each has an external ridge close to its anterior margin. The sides of the anterior portion of the clypeus extend posteriorly into the body of the post-clypeus, and the sutures that divide the clypeal lobes from the median part of the clypeus, are the clypeal sutures. The clypeal lobes continue under the ante-clypeus medially, and are joined to the ventral wall of the sucking-pump, whilst the mandibles are attached to a ridge on the anterior internal margin of each lobe.



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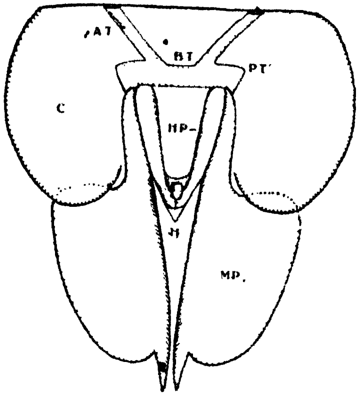

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FIG. 2.—Clypeus of *H. fidelis*.

p., posterior extension of floor of sucking-pump; *md.*, mandible.

FIG. 3.—Maxillary plates and post-clypeus of *H. fidelis*.

at., anterior arm of tentorium; *bt.*, body of tentorium; *pt.*, posterior arm of tentorium; *hp.*, apodeme of hypopharynx; *h.*, hypopharynx;. Other lettering as Figure 1.

Figure 3 is a diagram of the same part of the head shown in Figure 2, after the removal of the ante-clypeus and floor of the sucking-pump. Arising from pits on the epistomal suture are the anterior arms of the tentorium; these join the posterior arms which form a transverse bar through the back of the head; the median part of the bar is the body of the tentorium. Whilst in orthopteroid insects the tentorial structure is X-shaped, according to Snodgrass the π form, rather than the X form, is the more primitive type. Attached to the tentorial bar anteriorly are the apophyses of the hypopharynx and processes of the maxillary plates; the maxillary stylets are attached to the latter processes. The maxillary plates, which are largely hidden by the clypeus, and which may be removed as distinct sclerites, are not in any way connected with the genae.

FULGOROIDEA

The head-structure of members of this group have been studied by Muir (1926) and Snodgrass. The interpretation that follows is based on that already given for the head of *Hemiodoecus*.

Figure 4 represents the head of *Achilus flammeus* Kby., which differs from that of *Hemiodoccus* in that the clypeal suture entirely separates the median clypeus from the lateral lobes, the mandibular stylets are attached to the posterior internal corners of the clypeal lobes, and the maxillary plates are fused with the genae. Although in *Achilus flammeus* the clypeus is divided by a superficial transverse suture into an ante- and post-clypeus, with many fulgoroids (e.g., *Platybrachys* spp.), it still consists of a single sclerite.

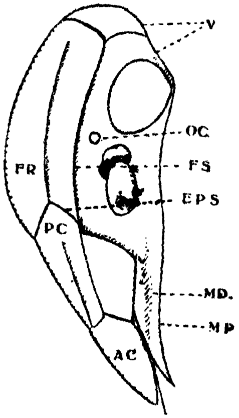

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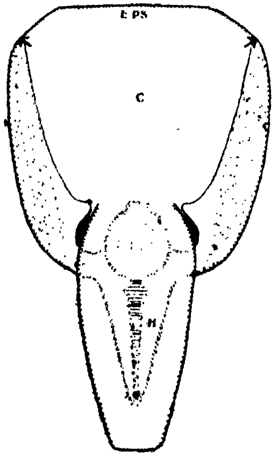
FIG. 4.—Head of *Achilus flammeus*.
p.c., post-clypeus; *a.c.*, ante-clypeus; *oc.*, ocellus. Other lettering as in previous figures.

Figure 5 represents the clypeus of *Eurinopsyche doddi* Dist. (Fulgoridae). The ante-clypeus projects from the post-clypeus, and bears the dorsal wall of the sucking-pump on its ventral surface. The ventral wall of the sucking-pump, anterior to the point at which it narrows posteriorly, is apparently joined to the rounded anterior internal margins of the sides of the post-clypeus. The median part of the post-clypeus supports the dilator muscles of the sucking-pump, and is separated from the lateral parts by superficial sutures; and the sides of the clypeus are recurved marginally, and to them are attached the mandibles at the points indicated by arrows.

The epistomal suture separates the clypeus from the frons, and the vertex forms the crown and sides of the head. Just as the presence of a median ocellus on a sclerite is sufficient evidence that the sclerite is of frontal original, so may the position of the lateral ocelli be used in determining the vertex.

Figure 6 represents the anterior part of the head of *E. doddi* viewed from behind, and is reproduced to indicate how the maxillary plates are separated from the genae by sub-genal sutures, and how the maxillary apodemes are fused with the posterior arms the tentorium. The apophyses of the hypopharynx lies below the tentorial bar (above in the figure). In all members of the Fulgoroidea that have been examined, the proximal ends of the anterior arms of the tentorium have been found unattached, but from their position it is probably that they originate on the epistomal suture. Dorsal tentorial arms occur in some genera, and arise from the anterior arms close to their approximation with the body of the tentorium.



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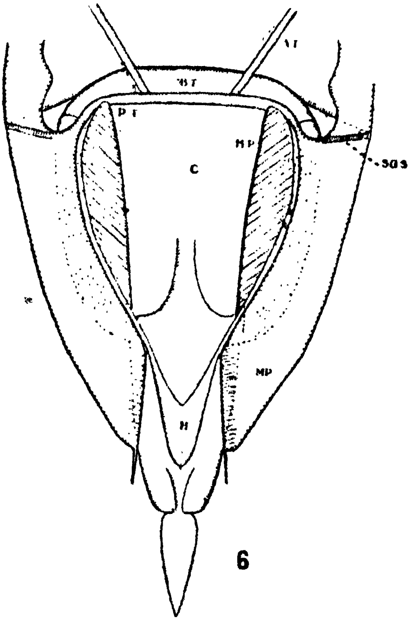

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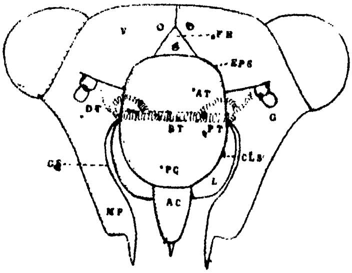
Fig. 5.—Clypeus of *Eurinopsyche doddi* in facial aspect.

Fig. 6.—Anterior part of head of *E. doddi* from behind. Lettering as in previous figures.

CICADIDAE

Although the morphology of the cicadan head has been investigated more thoroughly than that of any other hemipterous type, uncertainty still exists as to the homologies of the various parts.

Figure 7 is a diagram of a head of a cicada in facial aspect. Posteriorly between the eyes is the vertex, on which occur the paired ocelli. The larger part of the vertex lies on the crown of the head (Fig. 9), and is divided medially into two halves by the coronal suture which branches anteriorly into the epicranial suture; the arms of this suture enclose the frons which bears the median ocellus. Anterior to the frons, and separated from it by the epistomal suture, is the post-clypeus. The epistomal suture extends laterally on either side of the post-clypeus, to a position slightly in front of the antennae, where it joins the clypeal suture. The clypeal suture then extends to a position just in front of the suture separating the ante- and post-clypeus, where it meets the genal suture, whilst its apodeme, which narrows posteriorly, close to each antenna, widens anteriorly, and the apodemes from each side of the head meet under the ventral surface of the sucking-pump and may be fused with it. The lorae, or mandibular plates, are joined to the genae posteriorly, to the apodemes of the clypeal suture laterally, and to the circular membranous plate already described, medially; they thus have no apparent connection with the clypeus. On either side of the lorae are the maxillary plates, which are suspended from the genae, but not separated from them by a sub-genal suture. The head of the cicades differs from those of fulgoroids, in that the maxillary plates are widely visible in facial aspect; in the reduction in size of the frons; in the absence of a sub-genal suture; in the posterior extension of the clypeal suture; in the arching of the epistomal suture; and in the separation of the lorae from the clypeus.



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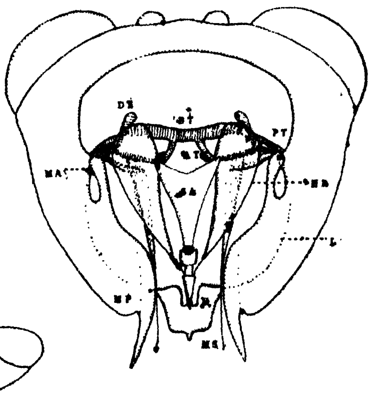

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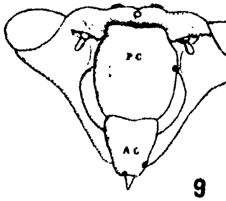

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FIG. 7.—Diagram of the head of a cicada in facial aspect.
gs., genal suture; *l.*, lorum.

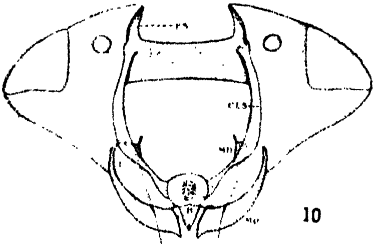
FIG. 8.—Head of *Tettigarcta tomentosa* from behind.
sa., apodeme of salivary syringe; *ms.*, maxillary stylet; *ma.*, maxillary apodeme. Other lettering as in previous figures.

FIG. 9.—Head of *Macrotristria angularis*.

Figure 8 is a diagrammatic representation of the head of *Tettigarcta tomentosa* White; the maxillary plates have been pulled apart to disclose the hypopharynx, and to separate the apodemes of the latter from those of the maxillary plates, to which the maxillary stylets are attached. Medially behind the hypopharynx is the salivary syringe and its apodeme. The apodemes of the hypopharynx, though closely apposed to the posterior arms of the tentorium, are not fused with them. The anterior arms of the tentorium arise from the epistomal suture, where it meets the clypeal suture, at the posterior apices of the lorae, and the dorsal arms branch from the anterior arms close to their points of origin.

CERCOPIDAE

The head structure of the Cercopidae, which has been studied previously by Doering (1922), is very similar to that of the Cicadidae, differing principally in the absence of a median ocellus. The greater part of the face of the head is occupied by the post-clypeus, which is separated from the vertex posteriorly by a small rectangular frons. The frons, which may be distinct, or amalgamated with the post-clypeus, always lies on the crown of the head, whilst the post-clypeus may be entirely ventral or extend on to the dorsal surface.



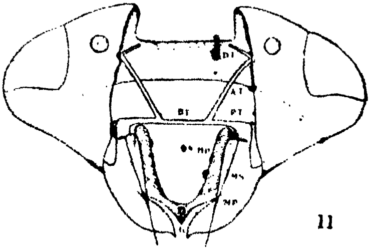


FIG. 10.—Head of *Hindola compacta* in facial aspect, the frons and clypeus having been removed.

FIG. 11.—Same as Figure 10, the lorae also having been removed. Lettering as in previous figures.

Figure 10 represents the head of *Hindola compacta* Walk. (Machaerotinae), from which the ante-clypeus, post-clypeus, frons, and antennae have been removed. Attention is directed to the clypeal sutures and their apodemes, which terminate close to the antennae, and to the attachment of the lorae to these apodemes and to the genae posteriorly. Figure 12 represents the lorae, clypeal apodemes, and mandibular stylets of the above species after removal from the head capsule, and shows the point of attachment of the stylets to the lorae. To the backward prolongation of each stylet are attached the retractor muscles, which arise on the dorsal wall of the head, whilst the protractor muscles are inserted on the bi-segmented connecting strut, and extend to the inner anterior margin of each lorum. Figure 11 represents the head after the removal of the lorae and their attachments. It will be noticed that the posterior

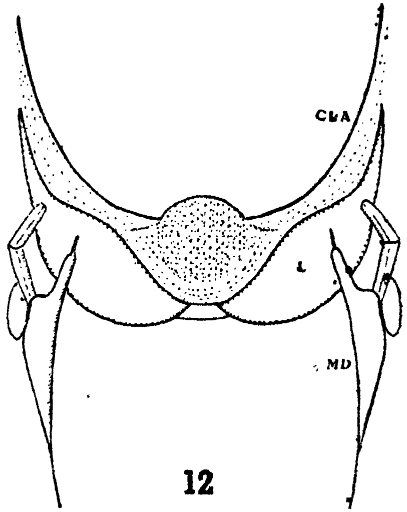


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FIG. 12.—Lorae, mandibles, and clypeal apodeme of *H. compacta*. *cla.*, clypeal apodeme.

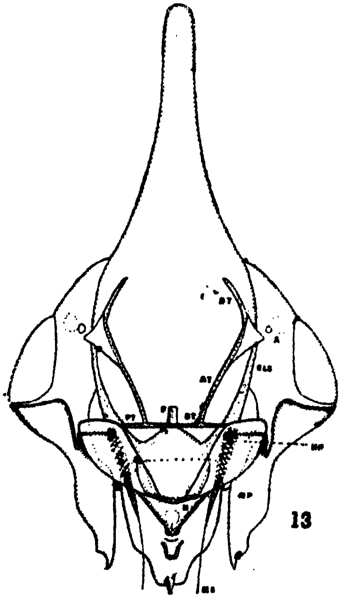

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FIG. 13.—Head of *Philagra parva* from behind, the dorsal surface of the post-clypeus frons and vertex having been removed. *a.*, antenna. Other lettering as in previous figures.

arms of the tentorium are fused with the maxillary apodemes, and that the latter are not fused with the hypopharyngeal apophyses distally, although joined to them anteriorly. Each maxillary stylet is articulated with a maxillary apodeme by means of a short transverse lever. The anterior arms of the tentorium, as in the Cicadidae, arise from the apices of the epistomal suture, where they join the clypeal suture.

In *Philagra parva* Don. (Fig. 13) the apodemes of the maxillary plates are reduced in size, whilst the posterior arms of the tentorium are fused with the hypopharynegeal apophyses. The narrow posterior prolongation of the ventral surface of the sucking-pump, shown in the figures, lies above the anterior junction of the clypeal apodemes, and connects with the pharynx.

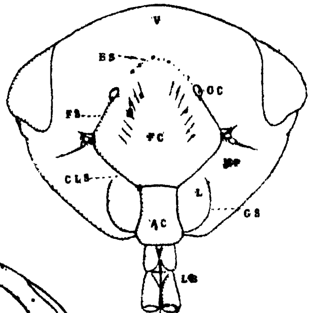
JASSOIDEA

The heads of jassoid insects differ from those of the groups already considered, in that with the majority there is no trace of the frons as a distinct sclerite, and the anterior arms of the tentorium, which serve to support the antennal muscles, are not attached to the body of the tentorium. Also, in the majority of jassoid families, although the clypeal suture is distinct, there is little development of a clypeal apodeme.

Figure 14 represents the head of *Eurymeloides pulchra* Sign., which has been chosen for description, since but for a narrow crown all the head lies in one plane. Between the eyes is the vertex, and medio-anteriorly lies the fronto-clypeus. As pointed out elsewhere (Evans, 1936, *a*), in the nymphs of some species of *Tartessus* (Euscelidae) a distinct rectangular plate occurs immediately behind the sclerite bearing the impressions of the dilator muscles of the sucking-pump, which in adult insects is fused with the post-clypeus. The rectangular sclerite referred to is the frons, hence the large median sclerite of most jassoid insects may be assumed to consist of all the frons and part of the clypeus. The rest of the head in facial aspect needs no further description.

When viewed from behind (Figs. 15, 16), just above the antennal scrobes are short struts, which are attached at their proximal ends to the antennal scrobes close to the point of junction of the clypeal and frontal sutures, and presumably at the apices of the lost epistomal suture. These are the anterior arms of the tentorium, the pits of which have been seen in the heads of nymphs of certain genera (*Aethalion* and *Rubria*). Joining the distal ends of the hypopharyngeal apodemes is a narrow bar; this bar consists of the apposed posterior arms of the tentorium. The apodemes of the maxillary plates are fused with those of the hypopharynx, and the maxillary stylets are attached to the former. With the Eurymelidae the ventral wall of the sucking-pump and its support are intimately joined to the hypopharynx, and form its dorsal wall.

As has been pointed out by previous workers, the homologies of the various parts of the labium are uncertain. It is possible that the segments labelled in Figure 15, mentum, prementum, and paraglossa, are derived from the corresponding parts of the mandibulate labium, but this not certain. A pair of small structures lying between the paraglossae may represent the glossae.



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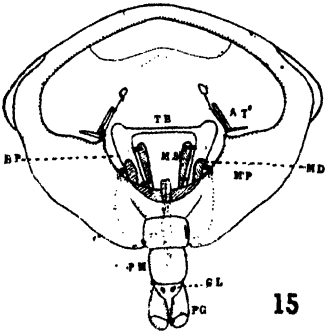

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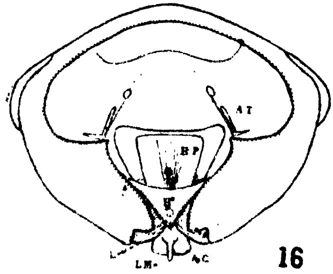

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FIG. 14.—Head of *Eurymeloides pulchra* in facial aspect.
lb., labium; *fc.*, fronto-clypeus.

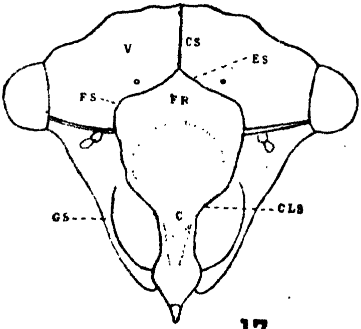
FIG. 15.—Head of *E. pulchra* from behind.
tb., tentorial bar; *m.*, mentum; *pm.*, prementum; *gl.*, glossa; *pg.*, paraglossa.

FIG. 16.—Same as Figure 15 after the removal of the labium and the stylets.
lm., labrum. Other lettering as in previous figures.

Figure 17 represents the head of *Aethalion reticulatum* L., after treatment in caustic potash, and is reproduced to show the presence of the coronal suture, which is absent in the majority of adult jassoids. There is no suture present between the ante-clypeus and post-clypeus, but an indistinct trace of a suture occurs, as shown, on the fronto-clypeus. This may indicate the boundary between the frons and post-clypeus; hence the suture branching anteriorly from the coronal suture is the epicranial suture, the suture that extends from the termination of the epicranial suture to the antennae, the frontal suture, which in turn connects with the clypeal suture. If this interpretation is correct, the rounded suture faintly discernible on the fronto-clypeus must be the epistomal suture, traces of which remain in a number of jassoids, as, for instance, *Smicrocotis obscura* Kirk.

Figure 18 represents the head of *Deltocephalus* sp., and is reproduced to show the presence of dorsal tentorial arms, which have not been noticed in any jassoid genera, other than with those that belong to the family Euscelidae.

It is possible that the diversity in the shape of the head that occurs among jassoid insects, may be due, in part, to the reduction in size of the anterior arms of the tentorium, since those muscles which were formerly attached to these arms will have taken upon new positions and set up new stresses. Whilst in the majority of jassoid families the frons is incorporated in the same sclerite as the post-clypeus, and the suture (when present) that divides the fronto-clypeus from the vertex is the epicranial suture, it is believed that in the Signoretidae, Pythamidae, and Eucanthidae, the frons is a distinct sclerite. In these families a small-circular area occurs on the crown of the head, bounded by the edge of the head anteriorly and by a raised carina posteriorly. The area referred to is the frons, the carina marks the epicranial suture, and the edge of the head separating the post-clypeus from the frons, the epistomal suture. The vertex consists of a narrow margin to the back of the head, which extends anteriorly on each side of the frons, and the ocelli lie on these extensions.



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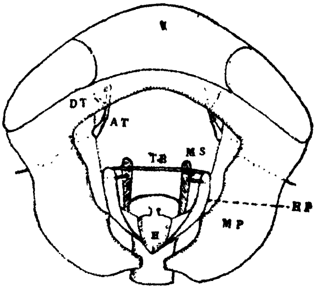

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FIG. 17.—Head of *Aethalion reticulatum* in facial aspect.

FIG. 18.—Head of *Deltocephalus* sp. from behind. Lettering as in previous figures.

MEMBRACIDAE

The membracid head is similar to that of the Jassoidea in the possession of a tentorial bar which has no connection with the anterior arms of the tentorium. It differs from them (apart from the Aethalionidae) in the retention of the coronal suture in the adult head. Muir was of the opinion that the one characteristic possessed by the head of Membracidae, which was different from those of the rest of the Cicadoidea, was that the post-clypeus (his frons) overlaps and often entirely hides the ante-clypeus. However, this character also occurs in the jassoid genus *Austrolopa* Evans (Ulopidae). In some of the membracid heads examined, the clypeal suture was not well-defined, so that the lorae appeared to be separated from the sides of the head rather by folds than by sutures.

STERNORRHYNCHA

The present study is principally concerned with the Colerrhyncha and Auchenorrhyncha, and only a few Sternorrhynchous types have been examined, belonging to the Aphididae and Psyllidae.

The principal feature in the head structure of these families is the separation of the head into two parts by a deep cleft, formed by the epistomal and sub-genal sutures. Posterior to this cleft the only distinct suture, which may be present or absent, is the coronal suture. With the Aphididae the frons is not defined as a distinct sclerite, and with the Psyllidae, only the median ocellus remains to mark its position.

The anterior portion of the head of certain aphides (e.g., *Pineus pini* Koch.) bears a striking resemblance to that of *Hemiodoecus*, in the development of the clypeal lobes, to the sides of which the mandibular stylets are attached, and in the small maxillary plates which are not fused with the genae. With the Psyllidae, clypeal lobes are not evident, and the maxillary plates are greatly reduced. Whilst with certain aphides the anterior tentorial pits occur close together towards the centre of the epistomal suture, with others, and with all the psyllids examined, they lie at the apices of the suture, which is somewhat arched medially. In the latter family the anterior arms of the tentorium are strong struts, that serve to brace the sides of the anterior part of the head.

Discussion.

Apart from the work of Snodgrass, the most recent and detailed study of the structure of the homopterous head is that of Myers, who, although particularly concerned with the cicadan head, referred to other groups and reviewed the earlier literature. In a paper published two years before that of Myers, Muir revised the views he had presented in earlier papers written in collaboration with Kershaw, and in a short note published in 1929 he altered his previous interpretation in so far as the tentorium was concerned.

VERTEX.—Little discussion has centred round the identity of the vertex, excepting with the Fulgoroidea, but confusion has been caused by the misuse of the term. The vertex is that part of the head that lies directly above the frons, whether the latter is distinct or incorporated in the fronto-clypeus. As pointed out by Baker (1923), the term is not synonymous with 'crown', since the vertex may lie in part on the face and in part on the crown, and the fronto-clypeus, post-clypeus, or frons, may extend on to the crown.

FRONS.—The frons is present as a distinct sclerite in the Peloridiidae, Fulgoroidea, and Cicadidae. With the Cercopidae it may consist of a small rectangular plate on the crown of the head, or appear to be absent, in which event it must comprise the hindmost portion of the post-clypeus. Muir considered the frons of fulgoroids to be the vertex, as does Snodgrass, although the latter believes a small triangular area bearing the median ocellus, such as occurs with some species, is of frontal origin.

With most jassoids and all membracids, the frons is incorporated in the same sclerite as the post-clypeus.

CLYPEUS AND LORAE.—According to Comstock (1920), although the clypeus almost always appears as a single sclerite, it really consists of a row of three sclerites, one in the median line and one on each side. The lateral sclerites are the ante-coxal pieces of the mandibles.

The clypeal lobes of *Hemiodoecus* may well be homologous with the ante-coxal pieces of certain mandibulate insects (e.g., the larvae of *Corydalus*), because of their position, and because of the attachment of the mandibular stylets to the surface of the anterior recurved margins. It is not difficult to trace the relationship between the clypeal lobes of *Hemiodoecus*, and of members of the Fulgoroidea, with the lorae of other groups. The transition will have been associated with the stresses set up by the dilator muscles of the sucking-pump, and their gradual backward migration on the clypeal plate, resulting in the enlargement of the median clypeus and the arching of the epistomal suture. This will have been accompanied by the simultaneous backward extension of the clypeal sutures and their apodemes.

The floor of the sucking-pump consists of a more or less circular membranous plate that is joined to the clypeal apodemes and the lorae. As pointed out by Muir, this plate is of double thickness, the two layers usually being fused together, but with insects shortly after ecdysis their separation is possible, when it is found that the lorae are attached to the ventral layer, and thus the median continuation does not actually constitute the lower surface of the mouth cavity, but its support.

Whilst with all types studied, with the exception of *Hemiodoecus*, the mandibles are articulated with the posterior corners of the lorae, their protractor muscles still retain their position on the inner anterior margins. That the lorae are not part of the mandibles, although frequently referred to as 'mandibular plates', has been shown by the embryological studies of Muir, who demonstrated that all the embryonic rudiment of the mandible becomes the stylet and its attachment. Both Muir and Myers considered the lorae as part of the genae, though Imms (1925) states that they are lateral developments of the clypeus, and reference to his figure shows that the sclerite in question is the post-clypeus. It is quite certain that Imms is correct and that their attachment to the genae is a secondary development.

Myers, following Muir, regarded the ante-clypeus as the whole of the clypeus, and the post-clypeus of the cicada as the frons. This is because he was not in agreement with Snodgrass in believing that the sucking-pump is part of the mouth-cavity, but considered it to be of pharyngeal origin. The suture that divides the ante-clypeus from the post-clypeus is a secondary development and not of universal occurrence.

MAXILLARY PLATES.—The maxillary plates have been shown by previous workers to consist of part of the maxillae, the embryonic rudiment of which becomes bi-segmented at an early stage, the basal joint becoming the maxillary plate and the distal joint the maxillary stylet.

Each maxillary plate consists of a wide, flat plate that tapers anteriorly to a point, and which is produced into the head-capsule posteriorly as an apodeme (possibly the cardo), or process, to which the maxillary stylet is attached. Although in *Hemiodoecus* the maxillary plates are distinct sclerites, in all Auchenorrhynchous families they are fused postero-laterially with the genae, and joined posteriorly by a thin membrame that lies between the floor of the hypopharynx and the base of the labium.

LABRUM.—The labrum is a narrow lobe suspended from the ventral wall of the ante-clypeus, and is usually known as the labrum-epipharynx. Imms, Doering, and Branch (1913) all identify the ante-clypeus with the labrum, but the attachment of the dorsal wall of the sucking-pump to the hind portion of the former sclerite, and the fact that no suture may occur between it and the post-clypeus, render their interpretation improbable.

HYPOPHARYNX.—The hypopharynx consists of a conical lobe that lies below the sucking-pump. Myers states that 'the lateral wings of the hypopharynx seem to be directly continuous with the lorae', which would suggest that the lorae are homologous with the superlinguae. However, though the dorsal wall of the hypopharynx is formed by the ventral wall of the sucking-pump and its support, the latter are not part of it. The salivary syringe is enclosed in the hypopharynx, and the aperture of the salivary canal is at its apex.

The hypopharyngeal apophyses are the most conspicuous structures within the homopterous head, and are probably homologous with supports of the hypopharynx such as occur in other orders.

SUCKING-PUMP.—Snodgrass has given a full and clear account of the origin and mechanism of the sucking-pump of Hemiptera, and as there appears to be no reason to doubt his interpretation, it need not be discussed here.

TENTORIUM.—The tentorium is an endoskeletal structure that serves to brace the cranial walls and give attachment to certain muscles. Snodgrass has suggested that all these muscles should take their origins on the sterna of the gnathal segments or on apodemal processes of the sterna, yet the tentorium appears to be a tergal structure. Helmsing and China have suggested that paired pits visible on the dorsal surface of each segment of the thorax of nymphs of *Hemiodoecus veitchi*, may be the ends of the thoracic apodemes similar to the frontal pits which mark the apodemes of the head. This suggestion lends support to the hypothisis that the tentorium is a tergal structure.

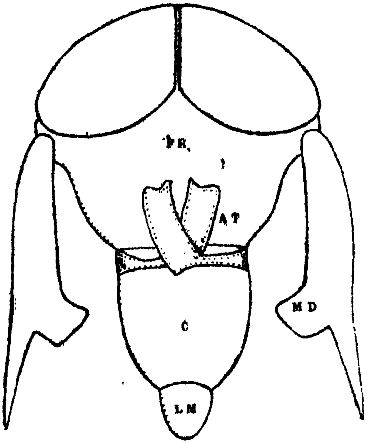
Considerable confusion has existed in the past over the tentorium. Myers accepted Muir's interpretation of 1926, and identified the anterior arms as the dorsal arms, although he drew attention to the fact that these arms joined the body of the tentorium, and that the latter was connected to the outer wall of the head capsule by invaginations which probably corresponded with the posterior arms of the tentorium. Although the dorsal arms of the pterygote tentorium may be united with the epicranial walls in the neighbourhood of the antennae, they are merely secondary outgrowths of the anterior arms, and can have no connexion with the posterior arms or body of the tentorium. Doering identified the tentorial arms correctly in the cercopid *Lepyronia quadrangularis* (Say), as did Snodgrass with the cicada *Magicicada septemdecim* L.

In 1929 Muir modified his views concerned with the tentorium, following the publication of a paper by Snodgrass (1928) on the morphology and evolution of the insect head, and advanced the view that the anterior arms of the tentorium arise from the hypopharynx and not from the anterior portion of the head-capsule. This assumption was based on Snodgrass's suggestion that endoskeletal arms, that spring from the base of the hypopharynx in Chilopods and Apterygota, may be homologous with the anterior arms of the pterygate tentorium. Hence Muir was of the opinion that the Hemiptera have not arisen from an orthopteroid stem, but from a more primitive one related to the Myriapoda and Apterygota.

It is, however, more probable that, whilst the hypopharyngeal apodemes of *Heterojapyx*, as figured by Snodgrass, are homologous with similar apodemes present in Hemiptera, and that apodemes such as occur with the Machilidae (Fig. 19), which arise from the margin of the head-capsule just anterior to the epistomal suture, are homologous with the anterior arms of the tentorium of pterygote insects, the two sets of apodemes referred to are not homologous with each other.

A study of the head of *Hemiodoecus* suggests that the Hemiptera have arisen from an early orthopteroid stem, and possess, in common with the Orthoptera, sternal apophyses that arise from the hypopharynx, in addition to two pairs of tergal invaginations that give rise to the anterior and posterior arms of the tentorium.

Tentorial arms that arise from pits on the epistomal suture, such as occur in *Hemiodoecus,* must be the anterior arms and not dorsal arms, and with their determination it is a simple matter to decide upon the homologies of similar structures in other groups, even though with the arching of the epistomal suture, the anterior tentorial pits lie at the apices of the suture and not towards its centre. In all the homopterous types examined, the posterior arms of the tentorium occur as a transverse bar, usually attached to either or both of the paired apodemes of the hypopharynx and maxillary plates. The pits of the posterior arms have not been located, but doubtless occur on the post-occipital suture, which is ill-defined, since it occurs on the membrame that separates the head from the thorax.



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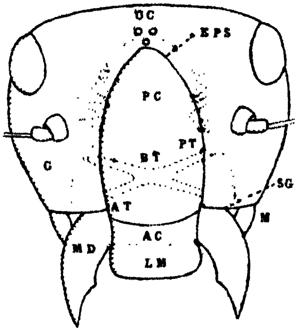

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FIG. 19.—Diagram of the head-capsule of *Allomachilis froggatti.*

FIG. 20.—Head of *Myopsocus australis.*

m., maxilla. Other lettering as in previous figures.

SUTURES.—It is believed that the various sutures that appear in the head capsule, with the exception of the post-occipital suture, have no relation to original metamerism, being only secondary inflextions of the cuticle.

Muir distinguished four sutures on each side of the head, the frontal, genal, maxillary, and labial sutures. His frontal sutures in the cicada delimited the lateral extent of the frons, continued beyond the antennae, and met in a middle line, and are thus identical with the epistomal suture of Snodgrass and the epistomal suture + clypeal suture of the present author. The apodeme of the clypeal suture, which is narrow near each antenna, and widens anteriorly, finally joining the one from the opposite side, was believed by Muir (1926) and Myers to represent the anterior arms of the tentorium; the circular membrane joining the apodemes, which forms the ventral wall of the sucking-pump or its support, was considered by them to be homologous with the frontal plate of the tentorium in some Orthoptera, and they identified the depressions that occur laterally at the junction of the ante- and post-clypeus with the pits of the anterior arms of the tentorium. Later, Muir (1929) considered the apodemes of the clypeal suture to be 'invaginations at the anterior end of the frontal suture', and not the anterior arms of the tentorium.

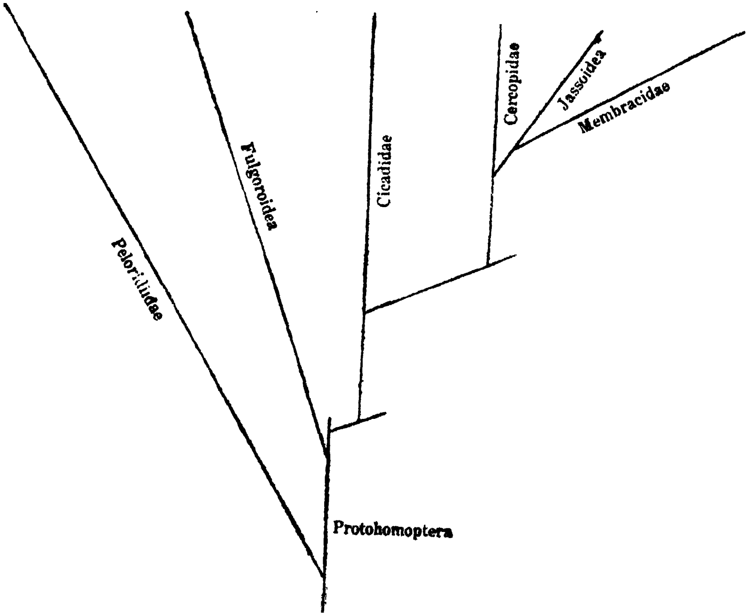
If it is accepted that the lorae are lateral developments of the post-clypeus, then that part of the suture that lies on either side of the post-clypeus anterior to the antennae can be neither the frontal nor the epistomal suture, but is the clypeal suture, its limit being marked by its apodeme. True frontal sutures, such as occur in *Hemiodoecus*, are elsewhere found only with fulgoroids and cercopids, where they lie on either side of the frons, and in some jassoids, where they lie between the epicranial and clypeal sutures. In the cicadas there is no trace of a frontal suture, the frons being defined laterally by the epicranial sutures, and anteriorly by the epistomal suture.

The genal sutures, which separate the lorae from the maxillary plates, must not be confused with the sub-genal sutures, since the latter, though distinct in *Hemiodoecus* and the aphides and psyllids that have been examined, are lost in other groups consequent upon the fusing of the genae with the maxillary plates.

The maxillary suture of Muir is 'very indistinct, and only recognizable as a crease'; it lies on the other side of the maxillary plate from his genal suture. Muir regarded the processes of the maxillary plates which lie alongside the apophyses of the hypopharynx, and which may be fused with the tentorial bar, as being the apodemes of the maxillary suture, and since he stated that the maxillary apodeme 'is the most complex and conspicuous structure in the head of the cicada ', it would seem that he had failed to separate the processes of the maxillary plates, to which the maxillary stylets are joined, from the apophyses of the hypophraynx.

The labial suture of Muir must be homologous with the post-occipital suture, since on it occur the pits of the posterior arms of the tentorium.

Only one more suture need be considered: that is the epistomal suture, which separates the frons from the clypeus. Snodgrass identified the suture that lies at the back and sides of the large median swollen sclerite in psocids and cicadas as the epistomal suture. Whilst not disputing this interpretation in so far as psocids are concerned, where no clypeal suture occurs, it is maintained that in cicadas the epistomal suture extends anteriorly only as far as the neighbourhood of the antennae, where it meets the clypeal suture, which, as has been mentioned in an earlier paragraph, may be recognized by its apodeme. The anterior tentorial pits occur at the junctions of the two sutures. With cercopids the epistomal suture is seldom distinct, whilst with most jassoids no trace of it remains in adult insects, the posterior margin of the fronto-clypeus being limited by the epricranial suture.



Phylogeny.—Various views have been advanced in the past concerned with the phylogeny of the Auchenorrhyncha. Osborn (1895) considered the Cicadidae to be the most generalized, followed by the

Membracidae, Fulgoroidae, Cercopidae, and Jassoidea, in that sequence. Kirkaldy (1906), whilst in agreement with Osborn in so far as the position of the Cicadidae was concerned, believed the fulgoroids to be the most specialized, and linked the membracids closer to the cercopids than to the jassoids. Singh-Pruthi (1925), as a result of a study based on the characters of the male genitalia, derived the Fulgoroidea from a lower level of the homopterous stem than the other groups, and the Membracidae from the same line as the Jassidae and Cercopidae, but at a lower level. The possible relationships of the various groups, as suggested by a comparison based principally on head-structure, are set out in the phylogenetic tree given above.

After the Peloridiidae, the Fulgoroidea are derived from the lowest level of the protohomopterous branch, not only because in the structure of the head, especially the clypeus, they resemble *Hemiodoecus*, but because of the primitive type of their genitalia, no subgenital plates being developed, and also on account of their tegminal venation. Certain fulgoroid genera have more complete venation, and less specialization by reduction, than is found in any other group of homoptera.

After the Fulgoroidea, there is little doubt that the Cicadidae represent the most primitive family, and next to them come the Cercopidae, which are possibly related to the mesozoic Scytinopteridae, since the tegminal venation of the latter is very similar to that of the present-day Machaerotinae.

The Cercopidae resemble the Cicadidae in the complete development of the tentorium, and in the presence, with many genera, of a distinct frons. The Jassoidea and Membracidae are placed at a higher level than the Cercopidae, because of their reduced tentorium, and since it is believed that the fusion of the post-clypeus with the frons, and in some genera the fusion of the front-clypeus with the vertex, is a recent development, brought about by the progressive backward migration of the dilator muscles of the sucking-pump on the cranial walls.

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PAP. & PROC. ROY. SOC. TASMANIA, 1937 (20TH MAY, 1938)

The Tasmanian Brush Opossum: Its Distribution and Colour Variations[1]

By

JOSEPH PEARSON

(Read 8th November, 1937)

Plates I-III

The present investigation was undertaken with the object of inquiring into the significance of the colour variations of the Tasmanian Brush Opossum, *Trichosurus vulpecula fuliginosus* Ogilby. The main investigation has not proceeded very far, and it is clear that elucidation of the genetical aspect of the problem will entail several years of experimental work. In the present paper the results of the preliminary inquiry are put on record, since they throw light upon the distribution and relative abundance of the two principal colour groups of *T. v. fuliginosus.*

Trichosurus vulpecula vulpecula Kerr, 1792, is found in Southern Queensland, New South Wales, Victoria, and South Australia. It varies in colour from the well-known silver-grey to the bluish-grey Monaro phase of the southern highlands and the yellow-bellied greyish animal of the north-west.

According to Iredale and Troughton (1934) there are seven varieties of the main species: one in Tasmania, three in Queensland, one in the Northern Territory, and two in Western Australia. These varieties have been partly established on colour characters, and it is found that the typical grey gives place to reddish, reddish-brown, brown, and black. I can find no exact statements as to what extent the grey individuals are found, if at all, along with the other colour variants. It would appear reasonable to believe, however, that grey was the original colour of this form, and that the melanistic departures from this colour are more recent developments.

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[1] A contribution to the Biological Survey of Tasmania.

In the case of the Tasmanian sub-species *Trichosurus vulpecula fuliginosus* Ogilby, there are two main colour forms, generally referred to as 'grey' and 'black'. Although each of these main divisions exhibits within itself many colour variations there is no difficulty in distinguishing a grey from a black.

> *'Grey' Opossum.*—In the case of the 'grey' the tail is invariably black from the tip for about two-thirds or three-quarters of its length, and the proximal part has the same grey colour as the posterior part of the body. The posterior half of the body is generally a true grey, either dark, medium, or light. In some cases the anterior half is the same colour, but more frequently there is a tawny or brownish tinge.
>
> *'Black' Opossum.*—The tail is uniformly coloured dark-brown or black. The posterior half of the body usually has the same colour as the tail. The anterior half may be of the same colour as the posterior, but more frequently there is a tawny or reddish tinge.

In both greys and blacks the individual hairs are lighter at the base and darker at the tip.

Nothing is known of the genetical significance of the two colours. Wood Jones (1924) states that the melanistic variety which occurs among the ordinary grey forms in South Australia is the offspring of ordinary grey parents. Mr. Brazenor, Mammalogist of the National Museum, Melbourne, has confirmed this from his personal knowledge. In view of the interesting distributional results obtained in the course of the present preliminary investigations it would appear to be necessary to make exhaustive genetic experiments with the greys and blacks in order to determine the true significance of the colour characters.

The preliminary investigations have been pursued along the following lines:—

1. To determine what other characters, if any, are associated with the two main colour groups. For this purpose body measurements and skull measurements have been taken.
2. To ascertain the relative abundance of the two main colour groups in different parts of Tasmania.

BODY MEASUREMENTS

At the present stage it has not been possible to make a sufficiently large number of measurements of freshly killed animals, but advantage was taken of the open season in 1937 to measure 318 greys and 260 blacks after the skins had been pegged out and roughly cured by trappers. This method is unreliable if accurate body measurements are required, as the pelt becomes stretched and distorted to some extent. Nevertheless, as a comparative method the measurement of dried skins probably has some value, and it is probable that the relation of the length of the tail (T) to the length of the body (L) is fairly reliable. In Table I an analysis of the results of measuring 578 dried skins is given. It will be seen from this table that $\frac{T}{L}$ varies in the greys from 47·2 per cent. to 60·6 per cent., with a mean percentage of 53·9. In the blacks $\frac{T}{L}$ varies from 48·3 per cent. to 58·5 per cent., with a mean percentage of 52·9. There is nothing in these figures to indicate that coat colour is correlated with the body measurements I have used. It is true that the number of skins measured was relatively small.

TABLE I

Body Measurements.

BRUSH OPOSSUM (GREY)

Number of Specimens	*District*	*Average Length from Snout to Base of Tail* (*L*) *cm.*	*Average Length of Tail* (*T*) *cm.*	$\frac{T}{L}$ x 100
				%
1	Port Davey	61·0	37·0	60·6
2	Mt. Barrow	58·5	35·0	60·0
3	Tasman Peninsula	63·0	35·3	56·1
41	Weldborough	63·5	35·4	55·8
75	Epping	62·4	34·5	55·3
14	Mt. Misery	67·6	36·5	55·[illegible]
21	Forrester Settlement (Scottsdale)	62·6	34·2	54·7
4	East Coast	64·2	34·7	54·0
9	West Coast Road	67·8	36·1	53·2
2	Huon	70·0	37·2	53·1
6	Swansea	63·8	33·7	52·8
55	Scottsdale	63·9	33·3	52·2
15	Mt. Roland	65·5	33·7	51·5
56	Ben Lomond	63·4	32·1	50·7
5	Dunorlan	68·5	34·5	50·5
6	New Country	63·0	31·7	50·4
3	Great Lake	67·3	31·7	47·2

Average of 318 = 53·9%

BRUSH OPOSSUM (BLACK)

2	Port Davey	65·0	37·0	58·5
7	Ben Lomond	59·3	33·3	56·2
14	Dunorlan	64·4	36·1	56·2
27	Forrester Settlement (Scottsdale)	62·9	34·9	55·5
21	Mt. Barrow	67·4	37·3	55·4
14	Mt. Misery	66·4	36·4	54·8
38	Epping	64·9	34·6	53·5
32	Mt. Roland	64·4	34·1	53·0
2	Great Lake	65·7	34·7	52·9
10	Brown Mountain, Runnymede	62·0	32·5	52·5
75	Scottsdale	64·7	32·7	50·6
8	Huon	70·4	35·3	50·2
4	East Coast	67·2	32·7	48·7
4	West Coast Road	74·7	36·0	48·3

Average of 260 = 52·9 %

SKULL MEASUREMENTS

In Table II certain skull measurements are given. These measurements were taken to ascertain if any correlation could be discovered between size and proportion of the skull on the one hand and coat colour and sex on the other. As only 27 skulls were examined, it is clear that too much reliance should not be placed upon these results, but the measurements serve to show, as far as they go, that in each of the characters examined there is considerable variability, and there is no indication that any particular skull character is linked with coat colour or sex.

TABLE II

*Skull Measurements**

BRUSH OPOSSUM (GREY)

	Sex	*A*	*B*	*C*	*D*	*E*	*F*
		mm.	%	%	%	%	%
A54/756	♂	73	56·1	43·8	20·5	56·1	78·1
A50/752	♂	81	69·1	48·1	19·9	60·5	76·5
A51/753	♂	83	67·5	42·2	19·3	56·6	72·3
A52/754	♂	91	67·0	45·0	19·8	57·1	74·7
A56/758	♂	77	66·2	45·4	24·9	58·4	72·7
A30/760	♂	84	70·2	47·6	20·2	59·5	73·8
A31/761	♂	83	69·3	45·8	20·5	57·8	75·9
A55/757	♂	85	68·2	45·3	21·2	58·8	76·5
A29/759	♂	78	69·2	46·2	21·8	59·0	79·5
A49/759	♀	87	66·6	45·4	20·7	55·7	74·7
A46/776	♀	75·5	70·2	42·4	19·9	57·6	78·0
A47/749	♀	80	68·7	40·6	21·2	56·2	78·7
A33/763	♀	72·5	69·0	44·1	20·7	58·6	78·0
A39/769	?	64·0	70·3	35·8	21·9	57·8	78·1
A36/766	?	81·0	67·9	46·9	19·7	58·6	76·5
A38/768	?	85	68·2	44·7	20·0	56·5	74·1
A35/765	?	78	71·1	42·3	19·2	57·7	73·1
A37/767	?	81	65·4	43·2	17·9	55·5	72·2
			BRUSH OPOSSUM (BLACK)				
A45/775	♂	81	69·1	45·7	21·0	58·0	75·3
A34/764	♂	79	70·9	44·8	20·9	56·3	78·5
A48/750	♂	86	68·6	43·0	19·8	58·1	74·4
A53/755	♂	87	65·5	44·8	18·4	56·3	76·4

* See next page.

TABLE II—*continued*

SKULL MEASUREMENTS: BRUSH OPOSSUM (BLACK)—*continued.*

	Sex	*A*	*B*	*C*	*D*	*E*	*F*
		mm.	%	%	%	%	%
A40/770	♀	83	67·5	43·4	19·3	57·8	73·5
A41/771	♀	76	70·0	44·7	20·4	58·4	73·7
A43/773	♀	82	66·5	46·3	20·7	56·7	75·6
A42/772	♀	88	69·3	46·6	20·4	54·5	77·3
A44/774	♀	81	67·9	44·4	21·0	56·8	74·1

* A = Basal length.
B = Zygomatic breadth (across the posterior ends of the Jugals).
C = Length of Nasals along middle line.
D = Greatest breadth of Nasals.
E = Length of palate (from the delicate bar forming the posterior boundary of the Posterior Palatine Foramen to the anterior end of the Pre-maxilla).
F = Along median dorsal line, from the posterior edge of the Sagittal Crest to the point of intersection of a line joining the Lachrymal foramina.
B-F are expressed as percentages of the basal length (A).

RELATIVE ABUNDANCE OF THE TWO COLOUR GROUPS

The figures of the Brush Opossums captured in the open seasons of 1934 and 1937 have been analysed. 58,407 records for 1934 and 47,528 for 1937 have been examined. These are summarised in Table III.

It will be seen that the main Bass Strait islands (Flinders Group and the King Island Group) have 100 per cent. greys. On the main island of Tasmania an interesting state of affairs is presented. This can best be appreciated by an examination of Plate I, in which the figures of Table III are plotted.[1] It is seen that the highest percentage of greys is to be found on a strip extending from the East Coast to the Central tablelands, and also in the isolated Tasman-Forestier Peninsula. From this central zone the percentage of greys gradually decreases, and we find a remarkably low percentage of greys in the two remotest districts, viz., in the region north of the Arthur River in the north-west corner of Tasmania, and in the Huon district in the south. No specimens have been recorded from the Arthur-Pieman Reserve, but I have been assured by Mr. Wigg, of the Animals and Birds' Protection Board, that there are no greys in that area. On his authority I have labelled the reserve 'all black' in Plate I. No information is available for the south-west corner of Tasmania, but it is reasonable to assume that there would be a low percentage of greys in that region.

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[1] Separate maps for 1934 and 1937 are not given, as it was found that the results of these two years agree in a marked manner, and the distributional map given in Plate A, though dealing with the combined years 1934 and 1937, might be taken for either of these years.

TABLE III

Distributional Records

	1934		*1937*		*% Greys*
	Grey	*Black*	*Grey*	*Black*	
Bass Strait Islands	5697	—	3775	—	100
Great Lake District	3124	445	1486	152	88·5
Tasman and Forestier Peninsulas	896	183	—	—	83·1
St. Marys District	1069	256	1523	348	81·4
Tunbridge-Ross-Campbell Town	1627	364	1729	395	81·4
Hamilton-Ouse-Dee	1846	470	937	177	81·0
Cradle Mt.-Western Tiers	244	59	—	—	80·5
Oatlands District	1081	305	3820	1042	78·6
Westbury-Deloraine-Mole Creek	1842	554	2754	736	78·3
Bothwell-Apsley District	990	255	1298	486	75·4
Ben Lomond-Mathinna-Fingal	481	246	1328	397	73·6
Lake Leake-Bicheno-Swansea	1459	503	1147	425	73·5
Copping-Campania-Runnymede	351	146	2334	907	72·0
Cressy-Epping-Evandale	1577	505	1412	623	71·5
Nile-Epping	1100	388	1423	623	71·5
Avoca District	3715	1644	905	242	71·0
New Town-Bridgewater (North Hobart)	1755	740	—	—	70·3
Cleveland-Conara	59	25	—	—	70·1
Newnham District (Launceston)	543	238	—	—	69·5
East Tamar-Piper's River-Bridport	317	183	155	33	68·6
Little Swanport-Buckland	569	262	—	—	68·3
West Tamar District	797	399	168	56	68·0
Mt. Barrow-Lilydale	507	257	124	60	66·8
Middlesex-Moina-Lorinna	748	416	—	—	64·0
Kempton-Tunnack	180	81	272	176	63·6
Meander District	515	297	—	—	63·4
St. Helens-Ringarooma-Pioneer	1489	892	1437	833	62·9
Lindisfarne-Rokeby	52	31	—	—	62·5
Boobyalla-Gladstone-Anson's Bay	272	157	524	376	59·9
Hayes-Brighton-Mt. Direction	341	206	53	70	58·8
Eldon Range-Franklin River-Zeehan	1389	841	396	447	58·0
Tunnel-Scottsdale	859	605	978	816	56·4
Latrobe-Kimberley-Harford	340	271	62	72	53·0
Nietta-Sheffield	487	510	934	822	51·6
Fentonbury-Macquarie Plains	223	212	—	—	51·5
Gunn's Plains-Sprent-Nook	235	304	—	—	43·6
Collinsvale-Uxbridge	73	178	203	333	35·0
Adamsfield-Florentine River	189	362	—	—	34·4
Ellendale-Fitzgerald-Uxbridge	269	514	68	144	33·8
Wynyard-Ulverstone (back country)	304	622	551	2061	24·1
Waratah	79	238	11	67	22·8
Calder-St. Valentine's Peak	13	64	—	—	16·9
North and East Sides of Huon Estuary	120	895	107	634	12·9
South and West Sides of Huon Estuary	113	891	80	609	11·4
Rocky Cape-Black River-Myalla	42	326	3	73	10·1
Huonville-Fern Tree	49	561	—	—	8·0
Yolla-Henrietta-Preolenna	1	20	—	—	4·8
Montagu-Marrawah-Smithton	47	411	3	1293	2·9
Total	40,075	18,332	32,000	15,528	
	58,407		47,528		
	105,935				

1934		*1937*	
Grey	*Black*	*Grey*	*Black*
68·6%	31·4%	67·3%	32·7%

General Considerations

It is perhaps premature to venture an explanation of this very interesting distribution of the two main colour forms of the Tasmanian Brush Opossum.

If the present depth-contours of Bass Strait are any indication of a former land connexion between Tasmania and the mainland of Australia, we can envisage that connexion as having followed the Wilson's Promontory-Flinders Island line. If the floor of Bass Strait were raised about 30 fathoms there would be a narrow strip of land connecting Wilson's Promontory with the north-east corner of Tasmania (see Plate III).[1] King Island would be connected with the north-west corner of Tasmania, and would be separated from the Wilson's Promontory-Flinders connexion by an enclosed basin having a narrow inlet at its north-west corner into the Bight. Such a land connexion would have enabled the grey Brush Opossum of South-Eastern Australia to reach the Tasmanian land-mass at its north-eastern corner. This agrees in the main with the character of the present distribution of the Brush Opossum in Tasmania. The melanistic type, so rare on the mainland, is also rare at the presumed point of entry of the species into Tasmania (i.e., at the north-east corner), but becomes increasingly abundant in a westerly and south-westerly direction. Thus, in Flinders Island only greys are found; on the east coast the greys predominate; in the extreme north-west and south-west the greys are very rare.

A difficulty to the acceptance of this hypothesis, however, presents itself. At the time the Bassian isthmus existed King Island was presumably linked up with the north-west corner, and should have shared with that area in the possession of a preponderance of blacks. In point of fact, however, King Island, like Flinders Island, possesses no blacks.

King Island, then, with 100 per cent. grey, is strikingly different from the north-west corner of Tasmania, which has nearly 100 per cent. black. Does this point to the fact that these two regions were not connected, as the present contour of the sea-bed between King Island and the North-West Coast would lead us to suppose? In spite of the deep water between King Island and the mainland and between King Island and Flinders Island, is it likely that King Island received its Brush Opossums direct from the mainland or through a connexion with Flinders Island?

An alternative suggests itself. If we are forced to the conclusion that the Bass Strait depth-contours give a correct indication of the shape of the former land-mass, it may be that when the grey form reached Tasmania it spread over the whole country as a grey animal, and that only at a subsequent period, after King Island had become separated from Tasmania, did the melanistic form assume importance and gradually supplant the greys in certain districts. There does not appear to be much support for this view, and in spite of the King Island problem I prefer the view that the blacks became more abundant as the Brush Opossum migrated farther and farther away from the point of entry.

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[1] The same effect would be produced by the lowering of the sea-level by the same vertical distance. Edgeworth David (1924, p. 139) stated that in the last Pleistocene glaciation the sea-level was lowered by 200 feet owing to the locking up of enormous volumes of sea water, which went to form some eleven millions of square miles of Pleistocene ice-sheets.

At the present stage of the investigations it would appear unprofitable to attempt to arrive at any solution of this very intriguing problem. The outstanding difference between the entire absence of blacks from King Island and the predominance of blacks in the north-west of Tasmania furnishes an enigma which appears difficult to explain in the light of our present knowledge.

The greys and blacks can hardly be designated geographic races specially adapted to the particular district in which they are found, since they live side by side in nine-tenths of the Tasmanian area. Nevertheless it is true that the blacks gradually increase in proportion towards the west and south. This state of affairs cannot be explained at present by the environmental conditions prevailing in the different parts of Tasmania, though no doubt an explanation will ultimately be found when we know these conditions more accurately. Two important factors, namely, elevation and rainfall, do not seem to affect the issue. A comparison of the maps given on Plates I and II would seem to indicate that there is no correlation between the relative abundance of greys and blacks in different parts of Tasmania and the incidences of elevation and rainfall. It is true that, generally speaking, a higher percentage of greys is found in the drier eastern districts, but this generalized statement will not bear close analysis, since the highest percentage of blacks is found in the north-west corner and the Huon district where the rainfall is not abnormally high.

Nevertheless it is interesting to note that Shull (1936) has drawn attention to the fact that many mammalogists believe that relative humidity affects coat colour, and it is thought that darker races are produced in more humid regions.

Neither do elevation contours offer any explanation of the interesting relative distribution of greys and blacks. This will be clearly realized by an examination of Plate I with Plate II, fig. 1.

Although the greys and blacks are so clearly defined there are so many grades of greys and blacks that it would appear that we are not dealing with two simple allelomorphs based upon one pair of genes. It is possible that there is one chief pair and several modifying pairs of genes. The genetic explanation of this problem promises to be a complicated one, and this aspect will not be dealt with in the present preliminary survey. It is proposed to carry out breeding experiments in the hope that more light will be thrown upon this interesting problem.

ACKNOWLEDGEMENTS

I am indebted to Mr. E. O. G. Scott, B.Sc., of the Queen Victoria Museum, Launceston, for assisting me in measuring the skins of Brush Opossums; to Messrs. Wilcox, Mofflin Ltd. and Neale Edwards Pty. Ltd. for offering facilities for examining skins and for giving valuable information regarding the distribution and colour varieties of the Brush Opossum; to Mr. A. L. Meston, M.A., for procuring opossum skulls; to Mr. E. le G. Troughton, of the Australian Museum, Sydney, to Mr. E. W. Brazenor, of the National Museum, Melbourne, and to Mr. H. H. Finlayson, of the University of Adelaide, for their help in regard to the colours of the mainland sub-species of *Trichosurus vulpecula*; to Mr. P. Wigg, of the Tasmanian Animals and Birds' Protection Board, for advice on the habits and distribution of the Brush Opossum; to Capt. Pearse for making the charts which illustrate the present paper; to Mrs. Lord and Mr. R. Boswell, of the Tasmanian Museum and Art Gallery, for assisting me in the arduous work of analysing over 100,000 opossum records; and to the Commissioner of Police for Tasmania for placing at my disposal the records of Brush Opossums captured during the 1934 and 1937 open seasons.

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PLATE I

Map of Tasmania showing relative distribution of Brush Opossums.

The large figures indicate the percentage of greys in different zones. The smaller figures mark the percentage of greys at individual stations.

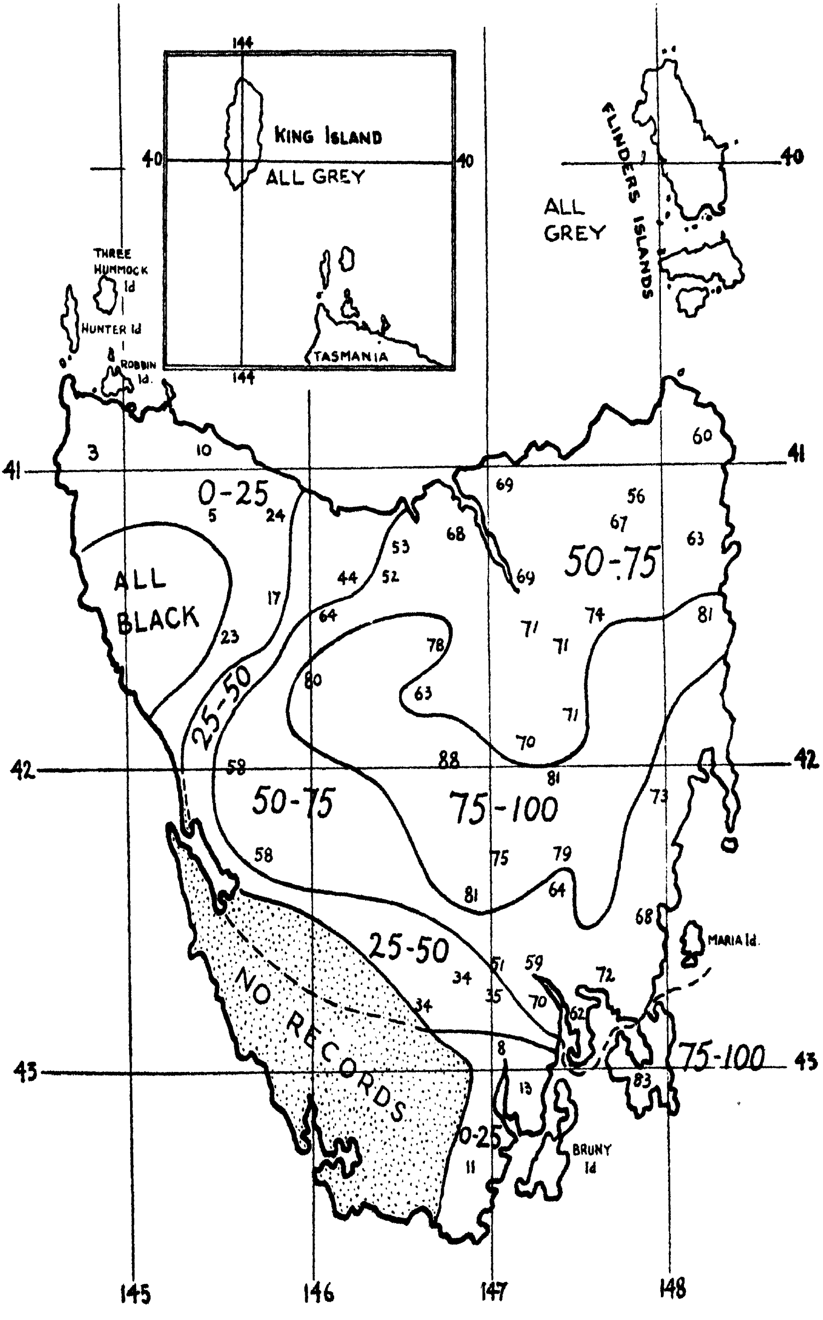

144
King Island
40
40
ALL GREY
144
TASMANIA
FLINDERS ISLANDS
40
ALL GREY
THREE HUMMOCK Id
HUNTER Id
ROBBIN Id.
41
41
3
10
0-25
5
24
ALL BLACK
17
23
25-50
60
69
56
67
63
68
53
52
44
69
50-75
64
74
81
71
71
78
80
63
71
70
42
42
58
88
81
50-75
75-100
73
58
75
79
81
64
68
MARIA Id.
25-50
51
59
72
34
35
70
34
62
NO RECORDS
8
43
43
75-100
13
83
0-25
11
BRUNY Id
145
146
147
148

PLATE II

FIG. 1.—Elevation contours in Tasmania.
FIG. 2.—Distribution of rainfall (in inches) in Tasmania.

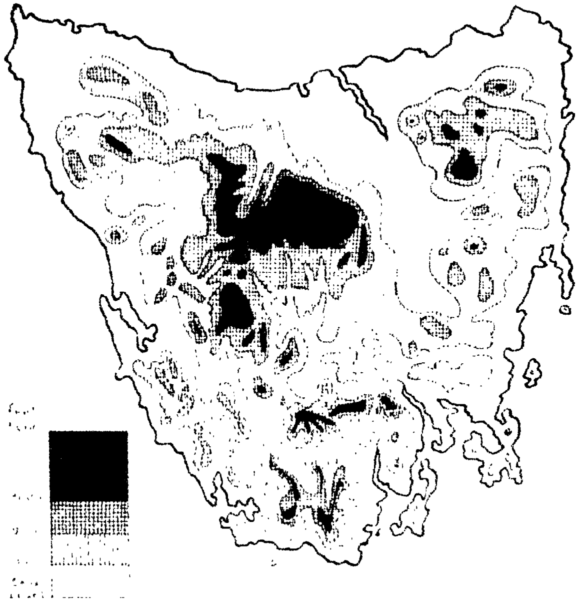


Fig. 1

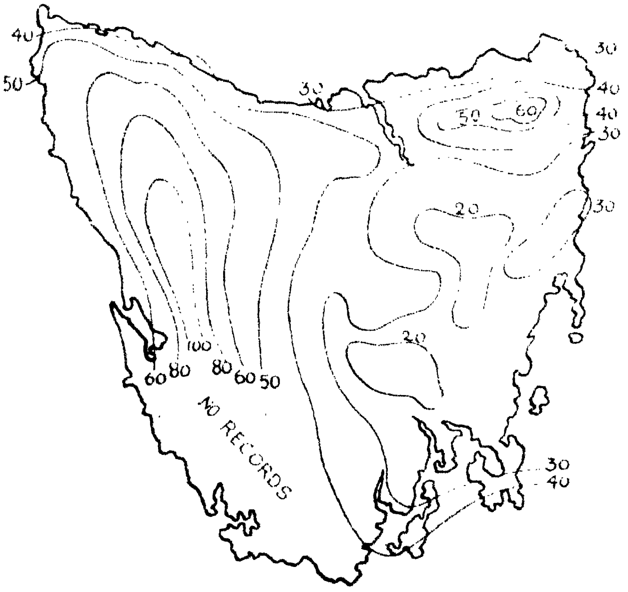
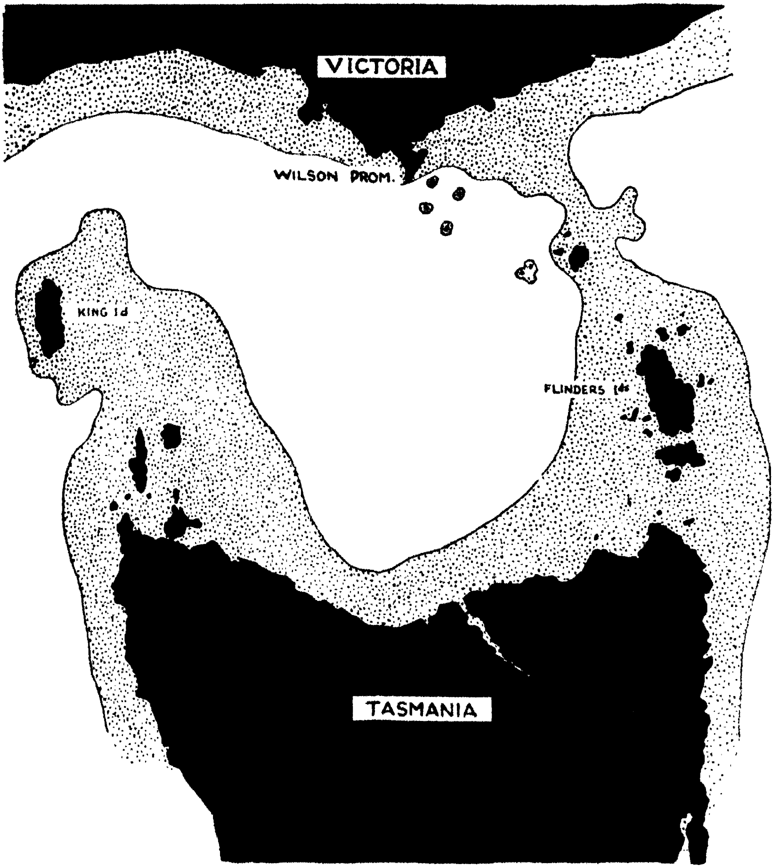

40
50
30
30
40
50
60
40
30
30
20
20
100
60
80
80
60
50
NO RECORDS
30
40

Fig. 2

PLATE III

Map of Bass Strait showing the present land outline (black), and the increased area (dotted portion) which could be produced by raising the sea-bed by 31 fathoms, thus indicating a probable former land connection between Tasmania and the continent.


VICTORIA
WILSON PROM.
KING Id
FLINDERS Ids
TASMANIA

PAP. & PROC. ROY. SOC. TASMANIA, 1937 (20TH MAY, 1938)

A Record of Volcanic Activity in Tasmania During Triassic Times

By

A. N. LEWIS, M.C., E.D., LL.D., M.H.A., and
A. H. VOISEY, M.Sc.

(Read 8th November, 1937)

Plate IV

Part I.—Field Occurrence

By

A. N. LEWIS

There has been no previous record of volcanic activity in Tasmania during the period occupied by the deposition of the coal-bearing rocks of Permian-Triassic age. Certain layers of flinty rock interbedded in the New Town coal measures used to be considered to be metamorphic products from contact with the intrusive dolerite. Whilst working on the occurrences of the dolerite in this area, I formed the opinion that these hard layers could not possibly be related to the dolerite intrusions, and they appeared to have been directly deposited in the sequence now visible. I took advantage of the presence in Hobart in March, 1937, of Mr. Alan H. Voisey, of the Sydney University, who has had considerable experience amongst the tuffs of New South Wales, to examine the layers in question. Mr. Voisey confirmed my suspicions of the existence of tuffs in the New Town coal measures, after a few minutes' inspection. He has been good enough to make a detailed petrological examination of specimens I selected as representative types. The result is a contribution to Tasmanian geology of outstanding significance, and workers in this State must be grateful for Mr. Voisey's interest and labours.

LOCALITY OF THE OCCURRENCE

The rocks which are the subject of this paper, and which will be referred to collectively as the *New Town Tuffs*, were found in the quarry now worked by the Hobart Brick Company, No. 110 Giblin-street, New Town, directly opposite the north-western terminus of Pedder-street. (Lewis and Murray's Map of Hobart, 1 inch = 1m — 052743.) This is near the *Adit* and *Brook's Engine Shaft* marked on Krause's Chart (Krause, 1884), and, as far as I can identify from the vague descriptions now extant, part of the workings of the Enterprise Coal Mining Company.

This quarry-face has now been cut back some 75 yards from the drainage creek which runs just north-west of Giblin-street and about 125 yards from the street. As the quarry is continually extending it is difficult to give a more exact datum. The tuffs are exposed from the floor of the quarry upwards for some 30 feet. The strata dip at about 10 degrees to the south-west, and thus the tuffs hitherto identified disappear beneath the overlying coal measures and sandstones within the short distance occupied by the quarry. No exposures exist further north or north-west where, a short distance away, a mass of dolerite abuts on the sedimentary series.

I have carefully examined the very meagre exposures in road-cuttings through the New Town basin and the better sections along the face of Knocklofty without tracing any further occurrences of tuff, and several specimens of doubtful appearance from these areas, and also from the sandstones between the 1450 and 2500 feet contour round Mt. Wellington, were all pronounced by Mr. Voisey to be of purely sedimentary origin. However, I have located another tuff of distinctive and almost scoriaceous appearance interbedded in the fresh-water shales of Spring Hill. This layer is about 24 inches in thickness, and is to be seen in the large sidling one-quarter of a mile north of Timsbury House. No other occurrence of tuff was discernible in the sections between Melton and the top of Spring Hill.

GEOLOGICAL HORIZON OF THE TUFFS

The rocks in question occur in the New Town coal basin, a typical member of the upper coal measures of Tasmania. The beds of tuff are in intimate association with shales replete with a rich equisetaceous flora. Splendid specimens of *Neocalamites* cf. *carrerei* Zeiller; *Phyllotheca australis* Brongniart; *Schezoneura* sp.; and many unidentified pith casts are to be found within inches above and below the tuffs. *Johnstonia coreacea* Johnston is very common in the section exposed by the quarry, with *Cladophlebis australis* Morris less common, and rich *Thinnfeldia odontopteris* Morris beds in the higher levels some 20 feet above the topmost identified layer of tuff. The rich cycad flora of Lord's Hill, a half-mile further south, is not to be seen at Giblin-street, and appears to be a slightly higher horizon. From this evidence the beds may be located near the top of the Rhaetic (Upper Triassic) (Walkom, 1926). They are not at the top of the coal measures, which may possibly just extend into the Jurassic System, and therefore Upper Triassic appears to be a reasonably safe determination.

The location of these rocks within the Tasmanian coal measures is more difficult, and, until I have completed my work on the Geology of Hobart, I am not quite prepared to say more than that the tuffs appear to be rather low in the coal-bearing series as developed in this area. The Geological Survey, in the *Coal Resources of Tasmania*, appear to have assumed that during the period of deposition Tasmania was one geographical unit, to the extent that each coal-seam was deposited over the whole country at the same time, and that seams in different places can be correlated by palaeontological groupings. Without stressing the point here, my observations lead me rather to the view that many separate coal basins were in existence, and it is impossible to arrive at a correlation, seam or stratum for seam and stratum, from one basin to another; also, that the plant life responsible was governed by environmental factors, so it is dangerous to rely on any particular grouping within the series as a basis of correlation; further, that the rocks which have been termed the *Felspathic Sandstones*, with the included coal measures, were deposited in a relatively brief space of time, during which there was no marked floral change sufficient to give a definite zoning key within the series. Fossil groupings are certainly very useful for correlating or differentiating several seams within one basin, but cannot be used in the same way between different basins.

I cannot accept, therefore, the Geological Survey's correlation of these coal measures as final, and previously published sections appear to me to be open to doubt, owing to the failure to have due regard for the many faults which occur in the area. At present, I am inclined to the view that the Knocklofty sandstones overlie the coal measures, but there is certainly a fault of some magnitude between the two beds. As far as my investigations carry me, I consider that the New Town coal-seams lie high in the felspathic series, and that the tuffs are within 200 feet of the top of the coal measures as developed in this area. This view, however, is not finally proved.

PREVIOUS ACCOUNTS OF THE NEW TOWN COAL FIELDS

Considering its accessibility and interest this area has received scant attention from geologists. In 1883 Mr. G. Thureau made a very brief report, which contains no information of present interest. In 1884 Mr. F. M. Krausè advised against drilling for coal. His report contains a map, which is virtually the only published account of the geology of New Town. He also added a detailed section. This, however, is hypothetical, in that it is based on a measurement of surface features. As Krausè failed to recognize the great Knocklofty Fault, with its throw in the neighbourhood of 2000 feet, and which separates the Permian mudstones from the Triassic coal measures, his section is worthless except as to the coal measures themselves. R. M. Johnston virtually copied Krausè's report into his *Geology of Tasmania*, and the Geological Survey did the same in 1922. (The geological map referred to on page 171 of *Coal Resources of Tasmania* does not appear to have been published.) R. M. Johnston did wonderful work in collecting and describing the fossil flora of the locality but contributed little towards a knowledge of its structural geology. (See, e.g., Johnston, 1886.)

FIELD OCCURRENCES OF THE NEW TOWN TUFFS

The rocks described in this paper have only been identified from the Hobart Brick Company's quarry and within a vertical range of about 30 feet by a horizontal distance of 50 yards. The identification should therefore not be generalized as typical of the series.

Three types easily distinguishable to the naked eye were found, these being described respectively as—

No. 1.—Greenish tuff. A soft greenish-brown rock, speckled with dark-green to black spots. No harder than the surrounding shale and only distinguishable in the field by its colour.

No. 2.—Yellow tuff. A very hard rock, somewhat resembling a quartzite in hand specimens, and clearly distinguishable by its hardness, which necessitates it being hand-picked from the quarried material before crushing for brick-making. Its colour is predominantly a dull buff.

No. 3.—Grey tuff. A bluish-grey rock, usually harder than the surrounding shale, but softer than No. 2. It is frequently impregnated with carbonaceous matter, which is sometimes well preserved as fossils.

All the above types occur in repeating layers. They are exactly interbedded with the fossiliferous shales of the coal measures. The average thickness is six inches, but twenty-four inches is attained in at least one layer. In many cases they merge sometimes at the top, sometimes at the bottom, sometimes on both sides, of the tuffaceous layer into normal freshwater shales. Sometimes the separation from shale to tuff is very clearly marked. The tuffs form one bed with the shales, and the difference is not easy to identify at the distance of a few yards. It is quite clear that both rocks followed each other in a normal sequence of deposition. In at least one layer of grey tuff (No. 3) the volcanic material overwhelmed growing plants.

W. H. Twelvetrees noted a peculiar rock in the coal-bearing strata at South Cape Bay. The present writer has examined these occurrences, and expresses the view that they are probably water-worn blocks of tuff or volcanic bombs of tuffaceous material. (Twelvetrees, 1915.)

Part II.—Petrological Descriptions

By

A. H. VOISEY

An examination of three rocks submitted to me by Dr. A. N. Lewis from the New Town coal field has yielded the following results:—

No. 1.—GREY CRYSTAL TUFF

(Greenish in weathered hand specimens)

The rock is a light greenish-grey colour, marked by numerous black spots each a millimetre or two in diameter. The fracture is irregular, and the surface is easily scratched with a knife. The presence of a large quantity of calcite is demonstrated by the violent effervescence when hydrochloric acid is applied.

When examined under the microscope the rock is seen to consist of angular grains of minerals and fragments of igneous rock, all being set in a matrix of calcium carbonate in the form of calcite. Decomposition has affected all of the minerals with the exception of quartz, and the calcite, which, for the most part at least, is secondary, has replaced many of the original constituents.

The dark spots so noticeable in the hand specimen are irregular masses of chloritic material, with minute particles of iron ore, which impart a dark colour to the fragments. Some of these represent igneous rock which has been ejected from a volcano. Under the high power objective they are seen to be composed of minute felspar laths, set in a chloritic groundmass.

Quartz is the most common mineral, and is in the form of irregular grains, generally about ·25 mm. in diameter. Some of the grains are wedge-shaped, and others have concave sides which suggest a volcanic origin. None of them show any signs of wear through transport by water.

Plagioclase felspar is present in small quantities, but is extensively decomposed, and it is probable that calcite has replaced much of the felspar which was originally present. One grain showing carlsbad and albite twinning occurs, and may be andesene. Apart from the chloritic material which forms part of the included rock fragments, the mineral chlorite is present, and has been derived from what were probably ferro-magnesian minerals originally in the rock. Small quantities of haematite and limonite are to be seen.

By far the most common constituent of the rock is calcite. All the other mineral and rock fragments are set in it, while the outline of certain grains suggests the replacement of other minerals. Such replacement is not an uncommon feature of tuffs, as they are usually porous and particularly liable to alteration by solutions. Some of the calcite is in the form of radiating fibrous aggregates, which give rather striking extinction effects when seen between crossed nicols.

The chemical composition of the fresh rock is in doubt owing to decomposition. It appears to be best described as a crystal tuff with basic affinities.

No. 2.—Grey Crystal Tuff

(Yellowish in weathered hand specimens)

The rock is grey in colour, turning to a buff owing to decomposition. It differs from No. 1 in that the characteristic dark spots are absent. It is calcareous, and effervesces strongly with hydrochloric acid.

Under the microscope angular wedge-shaped and triangular quartz grains, ragged chlorite, plagioclase felspar, and occasional rock fragments were detected. All these are set in a matrix of calcite.

Plagioclase is more abundant than in No. 1, but it is still subordinate to quartz. It is being replaced by calcite, but otherwise does not show a great deal of decomposition. Albite twinning is well displayed, and the high extinction angle of 32 degrees denotes the presence of the basic variety of felspar, labradorite. The grains are generally ·25 mm. in diameter.

Any ferro-magnesian minerals which were in the rock have been decomposed, yielding chlorite. A few fragments of haematite and limonite are present.

The inclusions of igneous rock are of interest. Most of them are lighter in colour than those in No. 1, and are less than half a millimetre in diameter. Under the high power objective some are seen to possess trachytic fabric, and to consist of minute felspar laths with interstitial chloritic material. The felspars are too small to permit accurate identification.

Several small rock fragments showing a mosaic of quartz and felspar between crossed nicols appear to be pieces of metamorphosed sedimentary rock, probably torn off the walls of the vent as the volcanic material burst through.

Calcite, mainly in the form of fibrous aggregates, makes up the remainder of the rock. The presence of labradorite denotes a basic rock, but the basicity is off-set somewhat by the quantity of quartz.

The rock is a decomposed crystal tuff with basic affinities.

NO. 3.—GREY CRYSTAL TUFF

This rock is light-grey in colour, and is characterized by the presence of thin bands of black carbonaceous material, which represents plant remains. It effervesces strongly with acid, and closely resembles rocks Nos. 1 and 2.

When examined in thin section it is seen to contain more quartz grains and fewer rock fragments than the other two rocks. Plagioclase is comparable in amount to No. 2, and is either andesene or labradorite. Chlorite and iron oxides are present in the usual quantities.

The carbonaceous material is black, and is closely associated with fibrous masses of calcite. Plant cells, probably the remains of secondary wood of a gymnospern, are seen.

Calcite, as usual, comprises the bulk of the rock. It has a fibrous spherulitic structure in part, and has replaced a large proportion of the other original constituents.

The rock is a crystal tuff of intermediate composition.

GENERAL REMARKS

The tuffaceous character of the rocks submitted is sufficiently proven by the nature and shape of the various constituents. Especially noteworthy is the presence of small fragments of rock, presumably thrown out by the volcano. The curved faces and wedge-like shape of many quartz grains constitute supporting evidence.

The presence of so much calcite is a notable feature of the rocks, but most, is not all, of it must be regarded as secondary. The original tuffs were probably far more felspathic than the specimens examined, and it is on this assumption, following the identification of some basic felspar, that the writer suggests they have basic tendencies.

It is not possible for the writer to state definitely the nature of the magma from which the tuffs were derived.

Part III.—Significance of the Discovery

By

A. N. LEWIS

(With suggestions by A. H. Voisey)

The mere record of tuffs from the Tasmanian coal measures is of itself sufficiently important to warrant notice. In future, attention should be directed to an endeavour to identify further occurrences. A useful correlation may be possible by this means. It will also be interesting to observe whether this igneous material is at all widely distributed throughout Tasmania.

Beyond this, however, we have here a definite record of volcanic activity during a time when none was previously suspected. The Tasmanian coal measures are included in a group of felspathic sandstones. It is difficult to see what rock would yield predominate felspar grains, since this mineral usually weathers out first, and breaks up first under the mechanical effects of transportation. It is possible that our felspathic sandstones are the result of the resorting by water of ash and other volcanic material erupted contemporaneously with the deposition of the coal measures.

No indication is yet forthcoming of the location of the volcano responsible for these tuffs. The absence of signs of wear due to transportation indicates a reasonably close proximity. The whole circumstance indicates the existence of a geography at the time very different from a continuous coal swamp. No igneous plugs or vents of an age absolutely contemporaneous with the formation of the coal measures have yet been identified, but it is possible that occurrences hitherto generally assigned to the later intrusions of dolerite may be associated with this phase of volcanic activity. The possibility of islands of permian mudstone amongst the coal swamps should also be borne in mind. No solution of the new problems thus opened up by the discovery can yet be offered, but they are mentioned as a guide for future observations.

The most important fact for future investigation is the relationship, if any, of these tuffs to the later dolerite intrusions. As Mr. Voisey has indicated, the specimens examined give us no clue as to the origin of the magma. Tuffs of highly doubtful origin occur in various places in Eastern Australia in rocks from Permian to Jurassic age. However, it has long been my opinion that the dolerite intrusions close the epoch of fresh-water deposition—that is, they should be assigned an age either late Triassic or very early Jurassic, and also that some igneous material must have found its way to the surface, although this has probably all been eroded away long since. I am also of the opinion that there were several phases of dolerite intrusions, giving rocks of slightly different chemical and physical properties. The dolerite was an undifferentiated basic magma of enormous bulk. It is not impossible that such an igneous phase would be preceded by an eruptive volcanic stage yielding a more acid rock, and that these tuffs are therefore the result of the opening phase of intense igneous acvitity, which later gave us our dolerite masses and associated structural deformation. Definite conclusions on these lines of thought must, however, await further field evidence.

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PLATE IV.—EXPLANATIONS OF MICROPHOTOGRAPHS.

Fig. No. 1.—Magnification 33/1. The large black patch is a fragment of volcanic rock, black being chlorite, and the lath-shaped crystals felspar. The white quartz grains are irregular in shape. Most of the grey background is calcite.

Fig. No. 2.—Magnification 33/1. The irregular outlines of white quartz grains are noteworthy. Black areas represent chlorite, and the grey speckled groundmass is calcite.

Fig. No. 3.—Magnification 77/1. Peculiar extinction effects in fibrous aggregates of calcite. Black patches are mainly calcite.

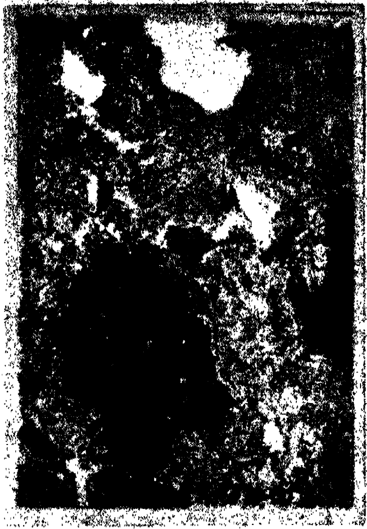

FIG. 1

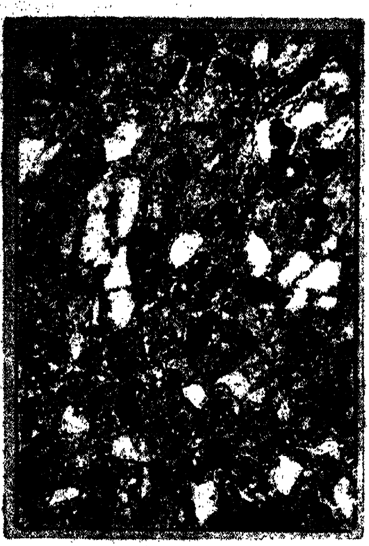

FIG. 2

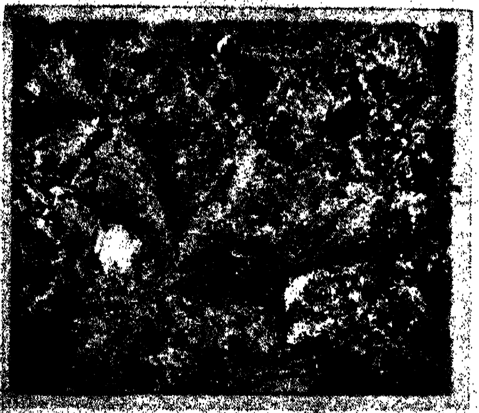

FIG. 3

PAP. & PROC. ROY. SOC. TASMANIA, 1937 (20TH MAY, 1938)

The Male Meiotic Cycle in the Genus *Eucalyptus*

By

A. L. McAULAY, F.Inst.P., and F. D. CRUICKSHANK, B.Sc.,
Physics Department, University of Tasmania

(Read 8th November, 1937)

Plates V-VI

This investigation was undertaken originally to determine the chromosome number of various eucalypts. Observations of the course of meiosis have been made in the pollen mother cells of eight species, and, as no work seems to have been carried out on meiosis in *Eucalyptus* previously, it seemed desirable to place the main results of the investigation on record in view of the important place which the genus occupies in our flora. The account of the meiotic cycle given should be reasonably typical of the process in Tasmanian forms at least.

MATERIAL AND TECHNIQUE

The collection of buds at the appropriate stage of development was made usually on a clear sunny day between noon and 4 p.m. The anthers were squeezed from the young buds into a tube containing fixative, which was then partially exhausted with a vacuum pump, in order to remove air from the tissues, and so ensure rapid fixation. The small size of the buds in some species made this process long and tedious.

The fixatives employed were (*a*) an alcohol, acetic acid, ferric hydrate mixture, (*b*) Navashin's modification of Karpechenko's fluid, and (*c*) Helly's liquid, a mercury bichloride fixative used as a check against artifacts which might be due to acetic acid fixation.

The first fixative was used in all preliminary work, for which it was admirably suited, as the light, slightly waxy anthers sank in it immediately, and were rapidly fixed. After fixation for two or three hours the anthers were washed in absolute alcohol, and were then ready for clearing and paraffin infiltration. Despite the apparently drastic nature of this fixative, the resulting preparations were remarkably good, and compared very favourably with material fixed in Navashin and Helly. These latter fixatives were relied on for all fine detail in the cytological structures.

Sections about 20 μ in thickness were cut by the paraffin method, and stained in gentian violet, haematoxylin, or sulphurous fuchsine (Feulgen). Photographic records have been made extensively during the investigation, as it is considered that the camera provides the best means of illustration, whenever it is applicable.

CHROMOSOME NUMBER

The chromosome number has been determined for *E. globulus*[1], *E. Johnstoni*[1], *E. linearis*, *E. pauciflora*, *E. viminalis*, *E. obliqua*, *E. salicifolia*, and *E. cordata*, which are fairly representative of the main types of Tasmanian eucalypts. In each of these species the haploid number has been found to be eleven.

The stage best suited to the purpose of counting the chromosomes is that of late diakinesis, which is particularly conspicuous in most of the material examined. The chromosomes at this juncture are compact, well-separated bodies dispersed throughout the nucleus (Plate V, figs. 1 and 2). This has been used as a standard stage for counting. In metaphase I and anaphase I the chromosomes are smaller and more closely crowded, often showing a tendency to clump, an appearance doubtless exaggerated by fixation. Many well-figured plates have been examined nevertheless, and photographs of some are appended. The counts have, of course, been confirmed at practically every subsequent stage. For example, the telophase II nuclei shown in Plate VI, figures 6-7, are from an anther in which it was possible to make many unambiguous counts, in spite of the fact that this stage is particularly difficult. Prophase II (Plate VI, fig. 3) includes one phase in which good counts can be made.

THE MEIOTIC CYCLE

The course of meiosis is of the type associated with a vesicular[2] nucleus. The second prophase appears to follow an unusual course. A detailed account of those phases which appear quite normal will not be given, but typical photographs are shown. The prophase I stages from leptotene to diplotene have not been examined in great detail, but there is nothing to suggest deviation from the normal here. It is hoped to examine the chromosome figures and chiasmata at some later time.

Metaphase I chromosomes appear as spheroidal bodies, and this, together with early anaphase figures, suggests complete terminalization of chiasmata. In metaphase I and anaphase I plates in *E. globulus* there is evidence of secondary pairing (Plate V, fig. 3, and cf. fig. 6). Owing to variability in the metaphase arrangements which have been observed, nothing further can be said about the pairing tendency yet, but there are many cells exhibiting chromosome patterns which make the conclusion difficult to resist.

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[1] See References (p. 44). [2] See References (p. 44).

The most interesting feature of the meiotic cycle is a very characteristic appearance which occurs during prophase II (Plate VI, figs. 2-3). In this, the chromosomes appear as well-figured bivalents, distributed in each nucleus over that half of the nuclear boundary which is nearest to the centre of the cell. When viewed from the poles of the cell they are seen to exhibit two saucer-like distributions, whose convex surfaces are towards each other.

The course of the cycle from anaphase I to metaphase II is briefly as follows:—

The formation of an interphase nucleus from the anaphase I plate commences with the appearance of nuclear sap, and hence the delimination of a nuclear boundary, accompanied by the movement of the chromosomes out towards this boundary. The amount of chromatin in the chromosomes decreases, and a single nucleolus is formed. The organization of the interphase nucleus is carried out very completely, particularly in *E. obliqua* (Plate V, fig. 8).

In early prophase II the chromosomes reappear, being distributed throughout the nucleus, which, by this time, has increased considerably in diameter (Plate V, fig. 9; Plate VI, fig. 1). The form of the chromosomes is difficult to ascertain here, but becomes clearer as the prophase continues. The later stages are characterized by a movement of the chromosomes in each nucleus towards the sister nucleus, culminating in their arrangement on the nuclear boundaries as two saucer-shaped distributions, the convex faces being towards each other. These are seen in lateral view in Plate VI, fig. 2, and in polar view in fig. 3. The two chromatids of each bivalent are attached to each other near their centres, presumably the region of the centromere, their distal parts being generally widely separated. The nucleolus has disapeared by this time, although occasional cells were found in which it had persisted to this stage (Plate VI, fig. 4, cell A).

Following this, the chromosomes condense into a compact form, the mutual repulsion of the chromatids in each bivalent having ceased apparently, while the nuclear-cytoplasmic interface disappears, and the chromosomes pass to their metaphase positions on the two spindles. The cell would appear to be in an unstable state at the time of the disappearance of the nuclear boundary, as then there is a marked tendency for the chromosomes to become aggregated. Fixation apparently causes a collapse of the matrix in which they are distributed. Judging from the infrequency of the occurrence of clearly defined chromosomes on plates in metaphase II, this phase must be passed through very rapidly.

Anaphase II and telophase II are quite normal.

We desire to express our thanks to the Trustees of the Science and Industry Endowment Fund for their generous aid which made the investigation possible in the first place. Its later phases have been assisted by the Commonwealth research grants to the universities. Our thanks are also due to the State Forestry Department, and to Mr. Rafferty of that Department, for assistance in the field.

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PLATE V

FIG. 1.—Cells of *E. obliqua* in diakinesis. In one cell eleven tetrads are just discernible. A nucleolus is present. × 900. Helly, gentian violet.

FIG. 2.—Cell of *E. Johnstoni* in late diakinesis. The nucleolus has disappeared. The photograph was made in two exposures superimposed on the same negative. × 1000. Alcohol-acetic, gentian violet.

FIG. 3.—Metaphase I. in *E. globulus*. Note evidence of secondary pairing and cf. fig. 6. × 2000. Helly, gentian violet.

FIG. 4.—Metaphase I. in *E. Johnstoni*. × 2000. Alcohol-acetic, gentian violet.

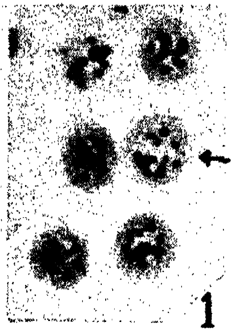
FIG. 5.—Early anaphase I. in *E. globulus*. × 2000. Helly, gentian violet.

FIG. 6.—Anaphase I. *E. globulus*. × 2000. Helly, gentian violet.

FIG. 7.—Late anaphase I. *E. globulus*. × 2000. Helly, gentian violet.

FIG. 8.—Late telophase I. *E. obliqua*. × 2000. Helly, gentian violet.

FIG. 9.—Early stage in prophase II. in *E. obliqua*. × 2000. Helly, gentian violet.



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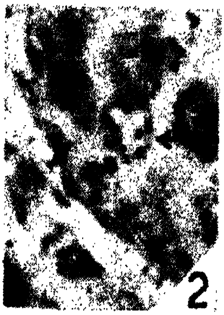

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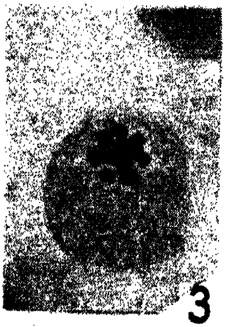

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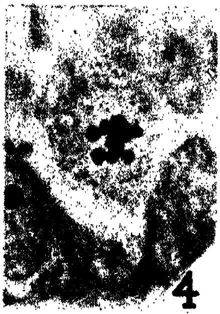

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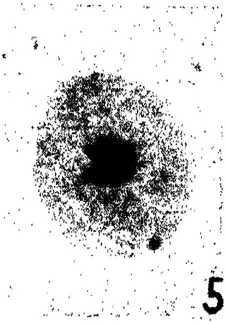

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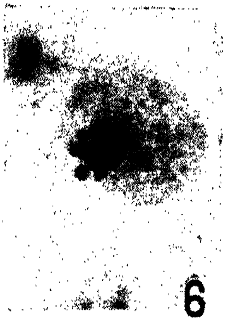

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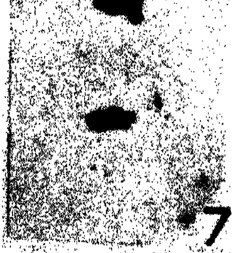

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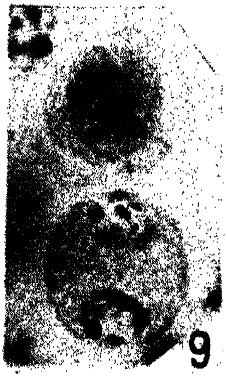

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PLATE VI

FIG. 1.—Later stage in prophase II. *E. obliqua.* × 2000. Helly, gentian violet.

FIG. 2.—Prophase II. *E. globulus.* 'Saucer' stage in lateral view. × 2000. Helly, gentian violet.

FIG. 3.—Prophase II. *E. globulus.* 'Saucer' stage seen from above, showing structure of bivalents. × 2500. Helly, gentian violet.

FIG. 4.—Cells of *E. globulus* in various stages of prophase II. Cell 'A' has almost reached the 'saucer' stage, nucleoli still present; cell 'B' is that shown in fig. 2; cell 'C' shows an oblique view of the 'saucer' stage, both nuclei being visible because of low magnification; cell 'D' shows chromosomes clumped approaching metaphase II. × 900.

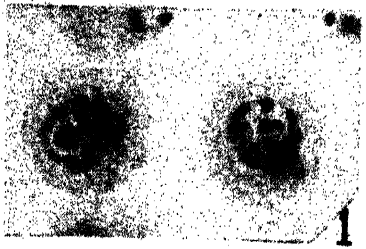
FIG. 5.—Metaphase II. *E. globulus.* × 900. Helly, gentian violet.

FIG. 6.—Cell in telophase II. in *E. obliqua.* × 2000. Helly, gentian violet.

FIG. 7.—The fourth nucleus of the cell shown in fig. 6. Eight chromosomes are shown on the periphery; the other three, one of which is just visible, are arranged close to the nucleolus. × 2000.

FIG. 8.—Later stage in telophase II. *E. globulus.* × 2000. Helly, gentian violet.

FIG. 9.—Completion of telophase, showing daughter cells fully formed within wall of parent cell. *E. globulus.* × 2000.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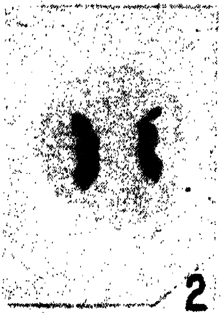
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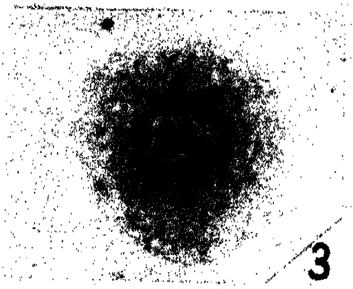
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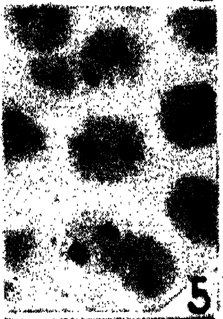
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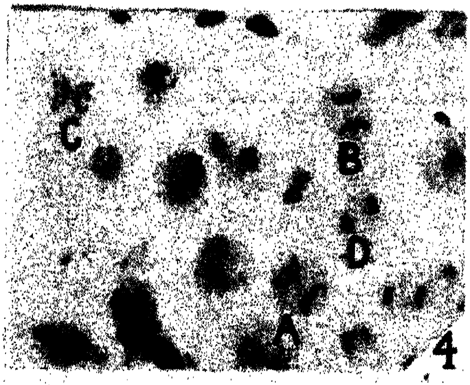

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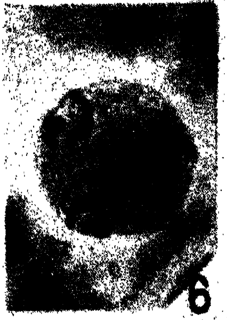
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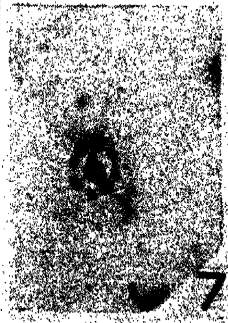
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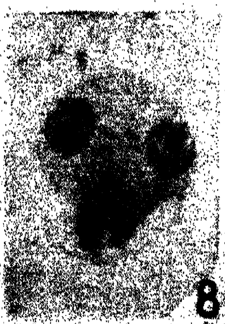
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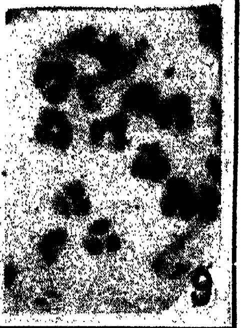
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PAP. & PROC. ROY. SOC. TASMANIA, 1937 (20TH MAY, 1938)

Evidence for the Existence of a Natural Hybrid between *Eucalyptus globulus* and *Eucalyptus ovata*

By

A. L. McAULAY, F.Inst.P.

(Read 8th November, 1937)

Plates VII-VIII

In the course of a joint investigation made at Bagdad by Mr. R. G. Brett and myself on suspected hybrids of *Eucalyptus globulus* and *Eucalyptus viminalis*, a tree was found by Mr. Brett which we considered to be a hybrid of *E. globulus* and *E. ovata*. After considering all other possible origins for the tree, including the possibility that it was an importation from outside Tasmania, we both reached the definite conclusion that it was a hybrid derived from the above two species.

Owing to the great dissimilarity between the young growth of *E. globulus* and *E. ovata*, this tree should provide an unusually good opportunity of testing for hybridization by raising seedlings. I have grown somewhere about fifty seedlings from it, and hope to raise ten or more to maturity.

It is considered that the result definitely confirms the theory that the tree is a hybrid, and, as at present the occurrence of natural hybrids is a controversial matter, it seems worth while to record the evidence. The seedlings range from something hardly distinguishable from *E. globulus* to something indistinguishable from *E. ovata*, through intermediate types. Plate VII, fig. I (*a*), is a photograph from a *globulus*-like seedling, fig. I (*b*) a photograph from an *ovata*-like seedling. Fig. II (*a*) is a photograph from a seedling of *E. globulus*, and fig. II (*b*) from a seedling of *E. ovata*, grown under the same conditions. These are shown for comparison. Figs. I (*a*) and (*b*) and II (*b*) are directly comparable; II (*a*) is from a rather older plant.

In Plate VII all the photographs are on the same scale. Points worth noticing are the square-sectioned thick stem and large pointed leaves on the *globulus* and *globulus*-like specimens, and the thin, markedly glandular stem and small oval leaves on the *ovata* and *ovata*-like specimens.

The resemblance of I (*a*) to II (*a*) and of I (*b*) to II (*b*), and the difference between I (*a*) and I (*b*), is not so noticeable in the photograph as in the actual plants, owing to the striking colour difference between young *E. globulus* and young *E. ovata*, which is matched in the extreme cases of the seedlings from the suggested hybrid.

Plate VIII, fig. III (*c*), shows some fruit of the suspected hybrid parent. Figs. III (*b*) and III (*a*) show fruit from *E. globulus* and *E. ovata* for comparison.

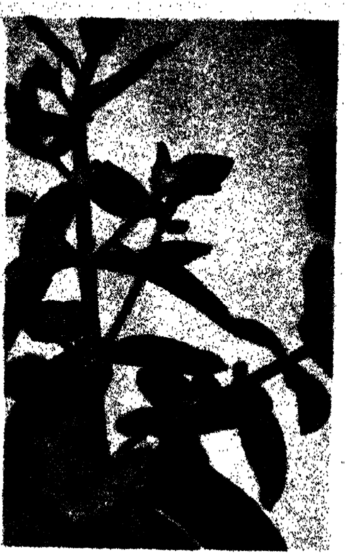
The above is a part of work done for the biological survey of Tasmania initiated by Dr. J. Pearson.

PLATE VII

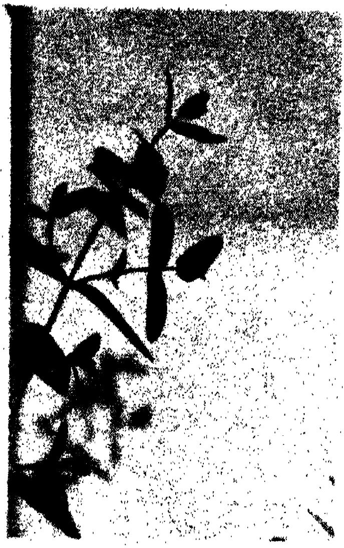
FIG. I (*a*), I (*b*).—Photographs of foliage of two contrasted seedlings from the suspected hybrid.

FIG. II (*a*).—Foliage from young *E. globulus.*

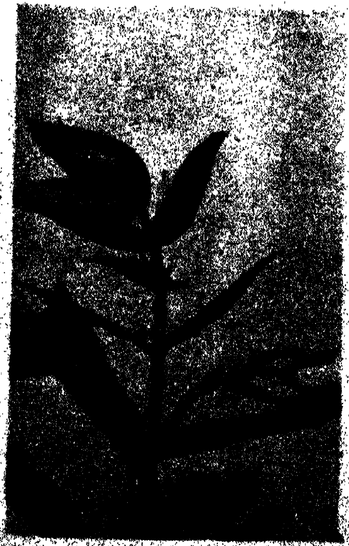
FIG. II (*b*).—Foliage from young *E. ovata.*



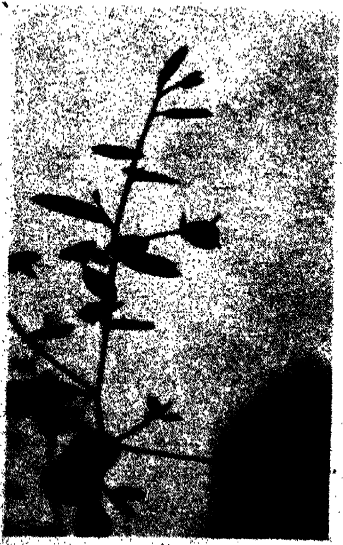
I(a)



I(b)



II(a)



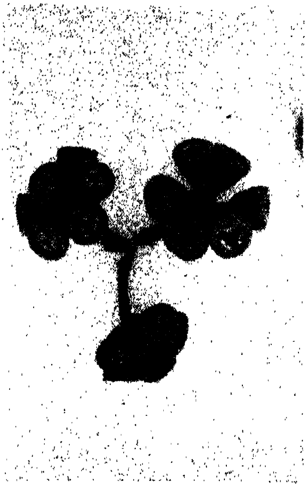
II(b)

PLATE VIII

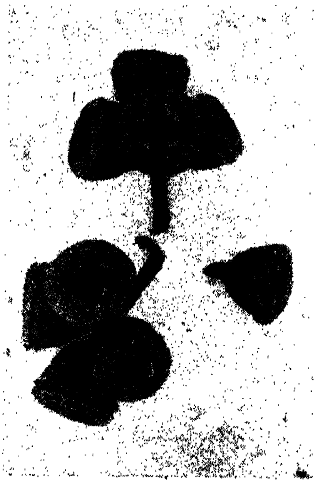
FIG. III (*a*).—Fruit of *E. ovata*.

FIG. III (*b*).—Fruit of *E. globulus*.

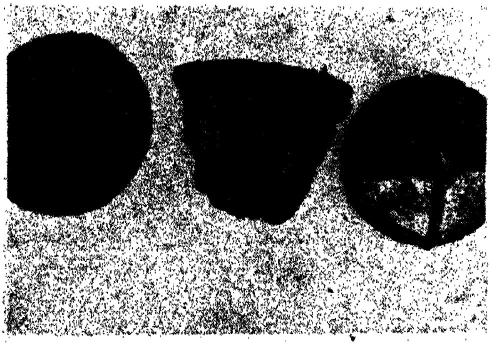
FIG. III (*c*).—Fruit of suspected hybrid.



III (a)



III (c)



III (b)

PAP. & PROC. ROY. SOC. TASMANIA, 1937 (20TH MAY, 1938)

Aboriginal Carvings Found at Trial Harbour

By

J. F. JONES

(Read 8th November, 1937)

Plates IX-X

Along the shore near the old settlement at Trial Harbour there are numerous middens of the Tasmanian aborigines. A large one is situated on the south side of the creek, and there still remain the hollows in the sandy soil over which the natives built their huts. Other middens are to be found along the seaside, both to the north and to the south.

On the northern side, about a quarter of a mile from the harbour, a large boulder of granite lies on the upper part of the beach beyond the reach of ordinary tides (Plate IX, figs. 1 and 2). In shape it resembles a broad-beamed decked boat. The top measures about ten feet by seven. It is smooth and fairly level. This rock evidently was the resort of the natives of the vicinity, who used the flat top for engraving their carvings and for other purposes. Probably it was thus used for many centuries, as the remains of incisions that have partly weathered away can be seen, in addition to those made more recently.

About a dozen rings have been made to a depth that, at present, averages about a quarter of an inch. It seems probable that, originally, this depth was greater, and has been diminished by the action of the sea and the weather. In size these rings measure from a foot in diameter to about half that width. The incisions forming the circumferences of the rings are about one and a half inches wide.

At the north end of the boulder there is a group of seven rings placed rather closely together. These are each of about seven inches in diameter. The other rings are scattered irregularly over the surface, and are mostly of larger size, the largest being fifteen inches from edge to edge. Besides these, there are arcs of other circles, indistinctly visible, the remainder having weathered away.

In addition to these circular markings there are several smooth hollows that appear to be the work of the natives (Plate X, fig. 1). The largest of these is about seven inches long, three inches wide, and, in the middle, about one inch deep, the depth lessening regularly towards the edges all round.

This depression appears to have been produced by friction—perhaps by grinding some hard substance, such as ochre, by means of a smooth, round stone. It resembles the hollows made by the Tasmanian natives in some of their stone implements, but is larger than any of these that the writer has seen. In addition to this large hollow, there are two groups each containing several smooth hollows of smaller size and of lesser depth.

The boulder on which these carvings were made is a solid mass of very hard granite. How the natives were able to mark it to the depth mentioned is difficult to understand. The writer hoped, before the visit to Trial Harbour commenced, that by excavating round the base of the rock and sifting out the surface soil, some of the implements used in forming the rings might be discovered. Unfortunately, however, after the necessary tools had been carried to the spot, it was found that the boulder was not above water-mark during storms, and that, at such times, the waves swirled almost all round it, and must have shifted the surface material again and again. Only one portion of the surface, situated on the landward side and protected by two large rocks, had not been thus disturbed by the waves. In this space, measuring about three feet along the side of the boulder, several implements were found, but they were only flakes, and probably had nothing to do with the formation of the rings. The smooth surface of the rock must have made it a favourite resort of the natives from the neighbouring camps. Its solidity and hardness provided an excellent anvil, or table, for the manufacture of the various implements they used.

How they formed the markings in such a very hard medium is, at present, only a subject for conjecture. Repeated hammering with a hard stone on the surface of the granite makes almost no impression, while the rock rings like metal when struck. If the rings were made by cutting or scratching the surface with a harder kind of stone, the edges would probably be sharper and the ring itself narrower, as requiring less material to be removed. If, however, the rings were formed by hammering the surface with a hard and heavy stone, they would be wide and shallow, as they are.

Their purpose can only be guessed. It is well known that it is customary among peoples like the Tasmanian aborigines to depict by drawings, paintings, or carvings, objects upon which they are dependent for their welfare, in the belief that such representations of these objects will increase or favourably influence their production. Some of the carvings found at the Bluff, Devonport, by Mr. A. L. Meston undoubtedly represent the haliotis, a shell-fish that formed an important part of the food supply of the natives living near the shore. The numerous circles found near Mt. Cameron West and at Trial Harbour do not appear to represent an article of food. A large ring found at the former place was surrounded by numbers of small markings cut into the rock. Do these rings represent the heavenly bodies? By a naked savage, dwelling on the exposed West Coast, where bitter winds from the south-west are common even in the summer months, the sun must have been regarded as a beneficent influence that might be induced, by means of the representations on the face of the rock, to come forth from the heavy clouds which so often obscured its kindly rays.

Or perhaps the rings, surrounded by the smaller markings, may have represented the moon and stars, which, to natives spending almost all their lives in the open, must have been objects of great interest. George A. Robinson and others who were in close touch with the aborigines in their wild state reported that they feared the moon, and would not travel at night. It may be that a desire to placate it and to diminish its evil influence was the motive that induced them to undertake the heavy labour of inscribing these circles.

In relation to the formation of such circular objects in stone by the Tasmanian natives, the writer desires to draw attention to another activity of the West Coast tribes that may have had a somewhat similar purpose to that suggested above. These natives, especially those living in the north-west corner of the island, were in the habit of shaping stones into a circular form. They did this sometimes with remarkable accuracy, the circular edges being as true as though produced by a lathe (Plate X, fig. 2). Their method of working was peculiar, and was nearly always the same. They selected a smooth, waterworn stone of oval shape, commonly of white quartzite, though other varieties were sometimes used. This stone was used for hammering, or, perhaps, was hammered to reduce its length. It was held so that blows were struck only with, or on, the ends. Many specimens can be found with both ends flattened and worn away, but without any scar from a blow appearing on any other portion of the stone, which, except at the ends, retains the waterworn smoothness that it had at first. By continued hammering, these ends were, in time, so worn away that the long axis of the stone became reduced to the same length as the shorter one. When this was accomplished, the natives began to hammer, not only with the ends, but with the edge, gradually producing a circular form flattened all round its circumference, and, but for the curved faces, resembling the casters of an armchair or sofa. It is interesting to note that, though so much hammering was done in reducing the length and in forming the circular edge, the two faces do not show the scar of a single blow, but remain smooth and unhammered.

These stones appear to have always been formed in the same manner, and may be found in all stages of development in the middens between Cape Grim and the Pieman River. They are commonest about Mt. Cameron West, Marrawah, and Bluff Point. Their weight is usually about three ounces, but many perfectly formed specimens weigh one ounce, while a few are little more than a half-ounce in weight. Some, however, are much larger, and weigh as much as two pounds, but the large ones are seldom as well formed as the lighter ones.

A very interesting fact in connection with this matter is that stones of precisely similar formation, size, and material, and apparently of precisely similar workmanship, have been found buried under limestone floors in Kent's Cavern, near Torquay, England. These can be seen in the British Museum, and date back to a very remote period indeed.

The very diminutive size and weight of some of the smallest Tasmanian hammer stones seems to preclude the notion that they were formed for hammering, and leaves their actual purpose a mystery.

In concluding this article the writer desires to point out that, on the West Coast of Tasmania, there are, at present, numerous evidences that the aborigines in this district had permanent dwellings, or, at any rate, occupied the same camps for considerable periods. Several sites of their camps, showing the positions of two to six or eight huts, are still to be seen, though the movements of hundreds of head of cattle, which are turned out each year to graze over the area, are producing sand-blows and causing the destruction of many of the sites.

If a model were made from accurate measurements of one or two of the larger sites, showing the kind of position the natives selected, it would probably be of great interest in years to come, when the originals will have disappeared.

In his 'Journal of Discoveries in Van Diemen's Land' (1827) Jorgensen makes frequent mention of the superior quality of the huts of the natives along the West Coast. In one entry he says: 'The huts, as well as baskets and other things produced by the Western natives, evince great ingenuity, and the nature of the country compels them to build compact dwellings to shelter them against the bleak winds blowing over a large tract of open country, not well supplied with fuel and of a piercing chilliness'. In another place he says that Native Hut River 'is so called from a peaceable tribe of natives who reside in good huts hereabouts'.

Again he says: 'On our way to Venable's Boat Harbour we observed a very compact native hut, far different (as are all huts in this quarter) from those seen to the Eastward. It was a complete piece of Gothic Architecture, in the shape of a dome, and presenting all the first rudiments of that Science. It was made to contain 12 to 14 persons with ease. The entrance was small and not above two feet high. The wood used for the principal supports had been steamed and bent by fire'.

While there is still opportunity, it is very desirable that the valuable and interesting information concerning the West Coast natives that is still available should be collected, and that our knowledge of their lives and customs shall be extended before it is too late.

PLATE IX

FIG. 1.—Granite boulder at Trial Harbour, bearing aboriginal rock carvings

FIG. 2.—Another view of the same

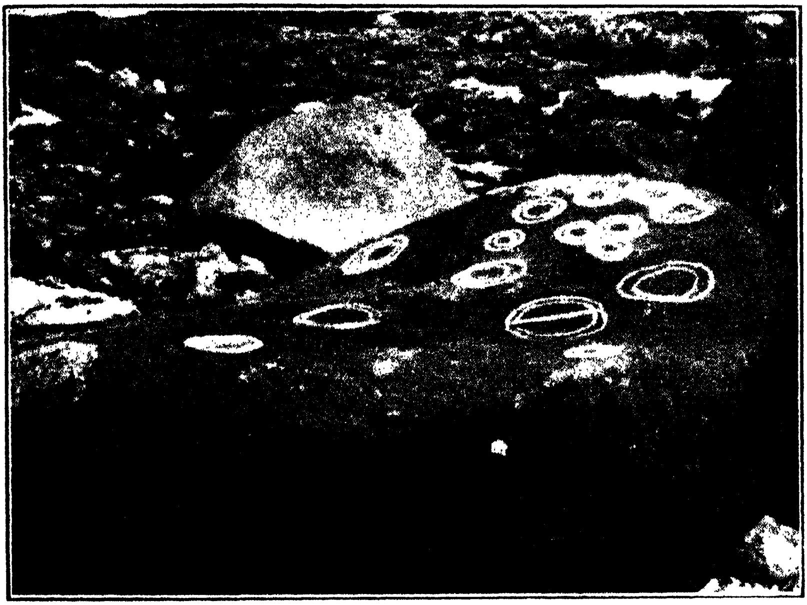


Fig. 1.

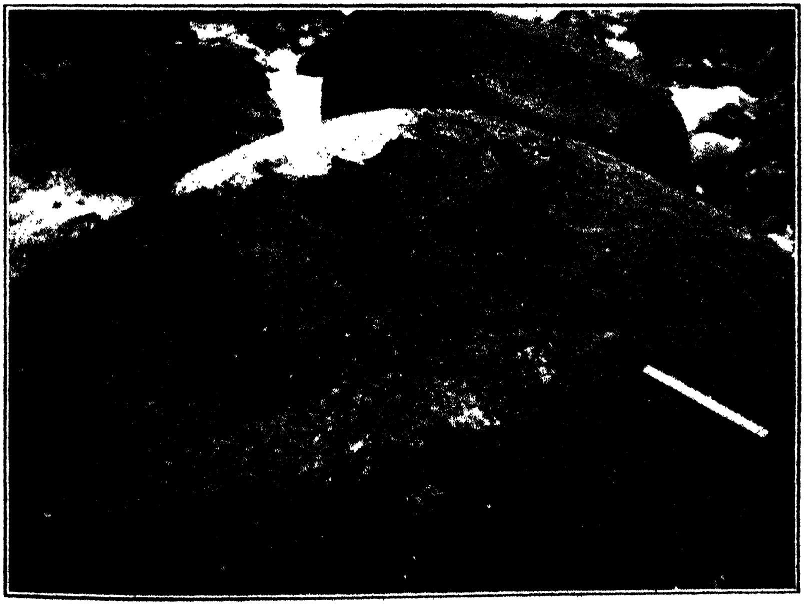


Fig. 2.

PLATE X

Fig. 1.—Worked hollows.

Fig. 2.—Completed hammer stones.

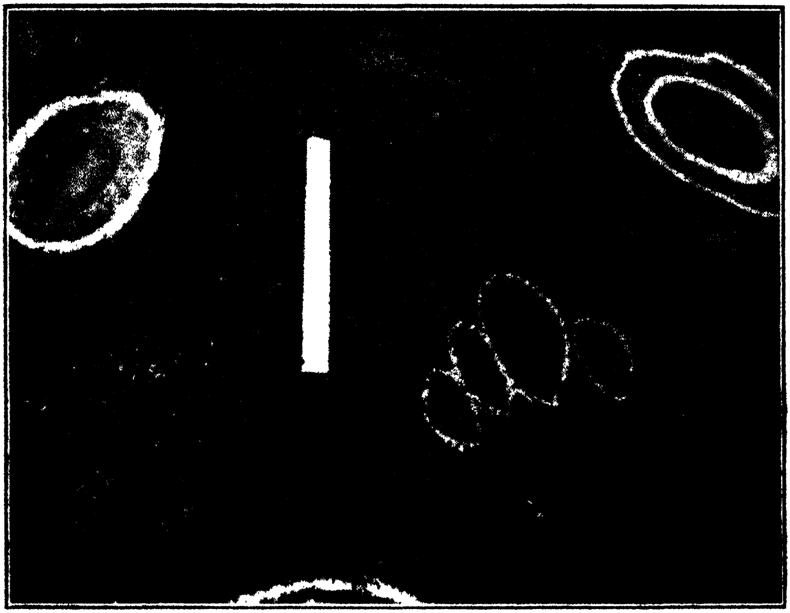


Fig. 1.

Fig. 2.

PAP. & PROC. ROY. SOC. TASMANIA, 1937 (20TH MAY, 1938)

D'Entrecasteaux: An Account of His Life, His Expedition, and His Officers

By

G. H. HOGG

(Read 12th April, 1937)

Plates XI-XIV; and 1 Text-figure

In November, 1737, two hundred years ago, at the Chateau D'Entrecasteaux, near Aix-en-Provence, Antoine Raymond Joseph de Bruni, Chevalier d'Entrecasteaux, was born. His father, the Marquis d'Entrecasteaux, was for a time President of the Parliament of Provence.

Educated at the Jesuit colleges of Aix and of Paris, he entered the navy in 1745 as a cadet, under the patronage of his relative, the great Suffren, took an active part in the Seven Years' War, and so distinguished himself in the battle of Minorca, where the English fleet, under Admiral Byng, was defeated, that he was given the grade of sub-lieutenant; serving later on the 'Hirondelle', he was noted for his skill in hydrographic work. In 1769, when Corsica was taken, he was given the command of a small boat—the 'Espion'—and in 1770 was promoted to the rank of lieutenant. Decorated with the Croix de Saint Louis in 1775, he sailed under Suffren until 1778, when he commanded a frigate in the Levant against the pirates who at that time menaced the trade routes. Captain in 1779, he commanded the 'Majesteaux', a vessel of 110 guns, and later the 'Puissant'. The extent of his knowledge, the integrity of his character, and the clearness of his judgment attracted the attention of the Marechal de Castries, Minister for Marine, who appointed him Assistant-Director of Ports and Arsenals under M. de Fleurieu.

In 1785, as commodore, he took over the command of the Indian station, where he displayed the French flag from the Red to the China seas; indeed, this was the first time that it had been seen in Chinese waters, the intention being to show the Emperor how it must be treated with proper respect.

His dispatches show how he boldly pointed out the faults of French colonial administration and the means of remedying them, how he foreshadowed French Indo-China, how he realized the value of Eastern trade, and warned his Government how British policy threatened French interests in the Far East. In addition to this political work, by studying the effects of currents and winds, by carrying out surveys, and by correcting the faulty charts of the English and Dutch sailors who had preceded him, D'Entrecasteaux made navigation in these Eastern waters much safer. At Pondichéry orders reached him to repair to the Ile de France, where, as Governor-General, he was to take over the administration of the Ile de France and Bourbon (Mauritius and Reunion) and the command of all the forces, both naval and military. He found the affairs of these colonies in great disorder, and it is interesting to note how the sailor transported from the deck of his flagship to the vice-regal residency took up the role of legislator and administrator. Currency, exchange, commerce, industry, and agriculture were dealt with in a systematic manner. In relation to agriculture, one of the troubles with which he had to deal was the same as that which developed in our own Australian states, land-hunger, the desire of the colonists to acquire additional land grants from the Crown whilst failing even to clear and develop estates already in their possession. These islands, commanding as they did the entrance to the Indian seas, were regarded by D'Entrecasteaux as of great strategic value for a naval base, where not only ships of war and merchantmen could be refitted and victualled, but whence expeditions could be sent all over Asia. He found the docks and arsenal in great disorder and the shipping in very bad repair, and he at once urged the Home Government to bring the defences up to date. ' So long ', he said, ' as Holland is the rival of Great Britain there is no fear of any attack, but from the day that there is a rapprochement between the two powers, the English may attempt the capture of these colonies '.

D'Entrecasteaux also envisaged the importance of Madagascar and other islands in relation to Great Britain, and considered the question of taking possession of it more than a hundred years before its occupation by the French Republic.

Military matters gave no little trouble. There was jealousy and ill-feeling between the French troops and the Irish regiment of Walsh which took all the tact of the governor to calm. The militia question was a source of further trouble, while the general body of the colonists was answerable for many disturbances; the cause of these was the colour question, which threatened a civil war, especially at the time of the mobilization of the militia. This he thoroughly reorganized, and at the same time put the general defences of the colony into a better condition.

The son of an old Catholic family, educated by Jesuit fathers, D'Entrecasteaux, although he escaped the scepticism of his age, never showed any trace of bigotry. Tolerant and liberal in his ideas, he disapproved of any narrowness or bitterness on the part of the clergy, and expressed himself strongly against their action in the case of mixed marriages.

A good number of Dutch colonists had settled in the colony, and there were prospects of further Dutch and English emigration, which the Governor-General wished to encourage. Certain regulations had been made by the church dealing with this question. 'Your measures', he said to them, 'to prevent the propagation of error are precisely those which have been made use of to oppose the establishment and progress of Christianity; they are purely human methods, which a politician might employ, but which are forbidden by the Gospels, and should never have been entertained by ministers of the true religion'.

Health reasons and family affairs influenced D'Entrecasteaux to resign his office, and arriving back in Brest in February, 1790, after three months' shore leave, he was given command of the 'Patriote'. By this time the revolutionary fervour was affecting the whole country. In September, 1790, Brest was in a state of excitement and almost of revolt; the King's officers were being denounced as traitors to their country, mutiny broke out in some ships, seditious sailors boarded the ships inciting the crews to revolt, and Huon de Kermadec and other officers were insulted.

In France, notwithstanding the storm and stress of the revolutionary times, great interest had been shown in the voyages of exploration to the Southern seas undertaken by Marion du Fresne and Cook. The mission of La Perouse especially had attracted attention, not in France alone, but in England, which had contributed to his expedition by supplying him with the nautical instruments of the illustrious Cook; an attention which became changed into keen concern when year after year passed without news of the 'Astrolabe' and 'Boussole', the ships in which La Perouse had sailed from Brest in 1785.

Some two years afterwards he had called at Botany Bay, just then founded by Commodore Phillip, but after quitting that port had never more been heard of. It was therefore but an expression of the nation's sympathy and concern when the National Assembly in 1791 passed a decree praying the King to dispatch an expedition in search of La Perouse and his companions. In this decree, as well as in the royal instructions, the objects of the expedition were clearly defined, namely, to search for La Perouse, and at the same time to make all possible exploration that might be useful and beneficial to navigation, to commerce, and to science. The following are extracts from the decree of the National Assembly dated February 7th, 1791: 'Decreed besides that the King be prayed to arm one or more ships, in which shall be embarked savants, naturalists, and draughtsmen; the commanders of the expedition to be given the dual mission of searching for M. de La Perouse and of making at the same time researches relative to science and commerce'. The extracts from the royal instruction read: 'He will study the climate and the productions of the countries which he visits; he will seek to inform himself as to the customs, morals, religions, and forms of government of the natives, their method of making war, their arms, &c.

Relative to these and other documents bearing on the expedition, it is interesting to note how strange an epitome of those troubled years of French history is written therein. The commander and officers holding their commissions from Louis XVI, the expedition, formed by a decree of the National Assembly, returning to a Republic, had the journals and dispatches printed by the command of, and dedicated to, Napoleon, Emperor of the French, King of Italy, Protector of the Confederation of the Rhine. Doubtless it was in part these years of revolutionary turmoil, of internal strife, followed by those of military glory and European conquest, which drew the attention of France away from southern latitudes, checked her ideas of colonization, and allowed England to occupy the Australian continent and the adjoining island of Tasmania.

The expedition, which had been fitted out at Brest under the superintendence of D'Entrecasteaux's friend, Huon de Kermadec, consisted of two ships, the 'Recherche' and the 'Espérance', each of 500 tons, with a crew of 92 men, and armed with six 8-pound cannon and two 20-pound carronades. The 'Recherche' was commanded by D'Entrecasteaux in person, the 'Espérance' by De Kermadec.

On September 29th, 1791, the ships sailed from Brest, and by the 30th were on the high seas, when, according to orders, D'Entrecasteaux broke the seal of his dispatches, and found that he had been made rear-admiral, while two of his officers, De Kermadec and D'Auribeau, were appointed post-captains; the new admiral accordingly read his commission and hoisted his fleg, which was honoured with the usual salute.

As soon as the ships were at sea a regime, which had been carefully thought out by D'Entrecasteaux for the preservation of the health of the crews, was brought into play. The ships were cleaned, aired, and fumigated every day, and the crews were divided into three watches, so as to give each man eight hours' uninterrupted sleep; moreover, strict supervision was kept on all sailors, who were compelled, if wet after a watch, to change their clothes.

These precautions were carried out partly on the recommendation of Captain Cook, whose crew had suffered severely from disease on his first and second voyages. On October 12th Teneriffe was sighted, and on the 13th the ships anchored and took in supplies, the naturalists of the party availing themselves of the opportunity to climb the famous peak and make collections of the flora and fauna of the island. Weighing anchor on the 23rd of October, the ships, as they made south, experienced frequent storms, stifling heat, and heavy rains; they crossed the line on November 28th, and entered Table Bay on January 17th. Next day salutes were exchanged with the fort, and the admiral landed, being formally received at Government House by the Administrator, M. Rhenius, and the Council of Regency.

The Abbé Bertrand (the astronomer), Blavier (the naturalist), and Ely (the artist) were left behind on account of ill-health; the Abbé had a narrow escape from death, falling from a precipice on Table Mountain while engaged in taking observations. Rossel, who had studied at the Paris observatory, took over the astronomical part of the work, assisted by Willaumez and De Bonvouloir.

While at the Cape D'Entrecasteaux received dispatches from the commander of the Indian station, reporting that the captains of two French ships had informed him that Commodore Hunter had seen traces near the Admiralty Islands of what might have been the remains of the uniforms of La Perouse's wrecked expedition. Commodore Hunter, on learning of these rumours, had contradicted them, the misunderstanding having been caused apparently by language difficulties. Although the admiral placed but little reliance on these reports, he considered it his duty to investigate their truth, and to change his route. Sailing from the Cape on February 16th, with the intention of passing through the Mozambique Channel, and then steering a direct course to the Admiralty Islands by the north of New Guinea, he was compelled to change his plans, as he found his ships such poor sailers that he would miss the favourable monsoons. D'Entrecasteaux decided, therefore, to sail to the south of Australia, and then make his way north to the Admiralty Islands. On March 28th the frigates sighted New Amsterdam, the exact position of which they determined; the island was surrounded by thick smoke anl enveloped in fire.

In the days which followed the ships encountered heavy gales, and were considerably strained, the 'Recherche' especially suffering from the heavy seas which she shipped, so that no attempt was made to investigate the south-west coast of New-Holland.

On April 21st land was sighted (the Mewstone) at half-past 9 in the morning, it being the intention of the admiral to anchor in Adventure Bay in order to obtain a supply of fresh water, as well as suitable wood with which to repair his battered vessels. Some mistake, however, was made by the navigating officer, and the expedition sailed into South-West Passage, anchoring for the night in a sheltered position. Although a boat had been dispatched at once to reconnoitre, it was too late to see much, but early next morning the same officers—De Saint Aignan from the 'Recherche' and De La Seinie from the 'Espérance'—left on a survey of the port, which occupied them for two days. De Saint Aignan reported that he had found 'a large harbour surrounded by highlands and sheltered from all the winds, the sea like glass, neither shoal nor rock to be seen', that there was an abundant supply of fresh water, and that he had noticed several deserted aboriginal huts.

Acting on these reports, D'Entrecasteaux determined to sail in, but a head wind prevented him; so next day, in the early morning of April 23rd, before the breeze had sprung up, the two ships were towed by their boats to an anchorage in what was to be known henceforth as Recherche Bay.

Bulletin de la Société de Géographie 3e trimestre 1894

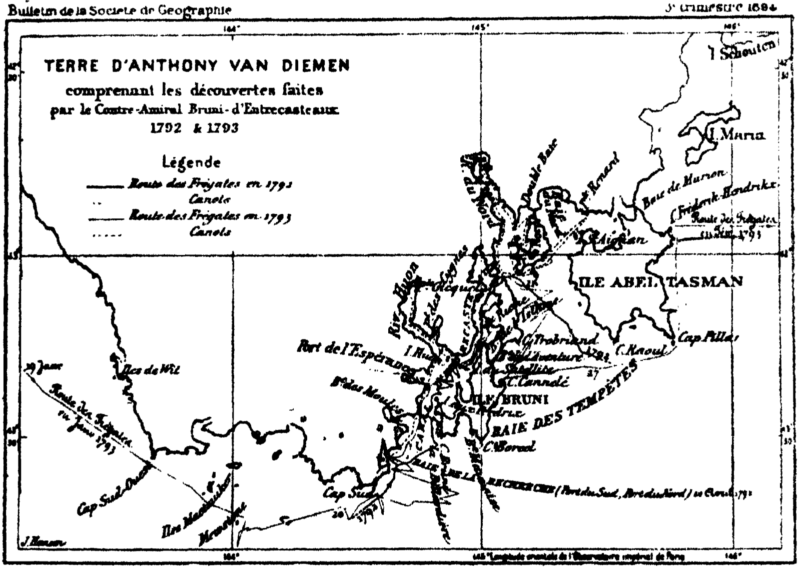

TERRE D'ANTHONY VAN DIEMEN
comprenant les découvertes faites
par le Contre-Amiral Bruni-d'Entrecasteaux
1792 & 1793
Légende
Route des Frégates en 1792
Canots
Route des Frégates en 1793
Canots
144°
145°
146°
I. Schouten
I. Maria
Baie de Marion
C. Frederik Hendrikx
Route des Frégates en Fév. 1793
Double Baie
Renard
Aignan
ILE ABEL TASMAN
Cap Pillar
C. Raoul
C. Trobriand
Baie de l'Aventure
C. Cannelé
ILE BRUNI
BAIE DES TEMPÊTES
C. Bernard
Riv. Huon
I. Huon
Port de l'Espérance
Baie de la Recherche (Port du Sud, Port du Nord) en Avril 1792
Cap Sud
Iles Maatsuyker
Cap Sud-Ouest
Baie de Wit
Route des Frégates en Janv. 1793
Longitude orientale de l'Observatoire impérial de Paris

Fig. 1.

Let me quote the admiral's own words when he saw this land for the first time:

> 'It would be vain for me to attempt to describe my feelings when I beheld this lonely harbour lying at the world's end, separated as it were from the rest of the universe—'twas nature, and nature in her wildest mood. At each step we met here the beauties of that nature abandoned to herself, there the marks of her decay, trees of an immense height and proportionate diameter, their branchless trunks covered with evergreen foliage, some looking as old as the world; closely interlacing in an almost impenetrable forest, they served to support others which, crumbling with age, fertilized the soil with their debris; nature in all her vigour, and yet in a state of decay, seems

to offer to the imagination something more picturesque and more imposing than the sight of this same nature bedecked by the hand of civilized man. Wishing only to preserve her beauties we destroy her charm, we rob her of that power which is hers alone, the secret of preserving in eternal age eternal youth'.

Some days were spent in boat expeditions, during which South Port, Port Esperance, and the Huon River were discovered by De Cretin, De La Seinie, and De Luzencay respectively, while surveys, soundings, and astronomical observations were also made. Partridge Island, Huon Island, and Satellite Island were named.

The most important discovery was made by the boat commanded by De Saint Aignan, who, accompanied by Beautemps-Beaupré was dispatched with a crew of 11 sailors and provisions for four days.

Leaving the 'Recherche' on May 18th at half-past 11, with a fresh S. to S.S.E. wind and rain squalls, he made good progress through the canal, and when late in the afternoon he caught sight of the open sea, and saw the waves breaking with violence on the shore, he was satisfied now that there was an open channel between the large island and the mainland (D'Entrecasteaux Channel).

Landing a little after 5 o'clock in a small cove with fine sand at the north of the island, they spent the night, which they felt very cold, notwithstanding the huge fires which they kept up. There they found some canoes 7 to 9 feet long and 3 to 4 feet wide in the middle, tapering to a point at each end. They were made of very thick bark, arranged lengthwise, and tied togeher with rushes or ligneous grass—really only rafts shaped like canoes. There they also saw some native huts, like those which they found at the mouth of the Huon, baskets, kangaroo-skins, &c. The return to the ship was delayed by a head wind, and the next night was passed in great discomfort owing to storms of rain and hail. The following day in the bay discovered previously by De Cretin, he allowed the boat to ground on a sand-bank at the head of the inlet, and in his own words: 'I did not hesitate to strip and leap overboard, and to wade ashore, holding a gun in one hand and a compass in the other. On landing I heard the sea thundering on the other shore, and, crossing a tongue of land a cable's length across, I found myself on the shore of Adventure Bay. The cold did not prevent me from taking several observations nor from making further sketches. Recrossing the same tongue of land through the scrub, some of which was very prickly, I returned to the boat as I had left it'. After two miserable nights of squalls, rain, and hail, their provisions exhausted, they finally regained their ships. During their cruise Saint Aignan and Beautemps had made numerous observations and sketches.

D'Entrecasteaux, anxious to continue his search for La Perouse, thought of availing himself of the favourable winds which were blowing and sailing south, but yielded to the wishes of his officers, who wanted to navigate the ships through the newly discovered strait, hoping, as he did himself, to make perhaps further discoveries. The channel was so sheltered and the breeze so light that it took four days to pass through it, the ship anchoring from time to time in order that observations of all kinds should be made, and that Beautemps-Beaupré should receive every assistance in his chart-making. 'A sailor', he says, 'can never be accused of exaggeration in showing enthusiasm at the sight of a harbour 24 miles long, everywhere safe, without reefs, where one can drop anchor without fear, and approach without danger a cable's length from the shore; of an aspect attractive, although somewhat monotonous at first sight because of the uniform greenness of the trees with which the hills, heaped one upon another as they are, are covered from the very summits down to the water's edge, varied, however, by the picturesque scenes presented by the windings and numerous bays of the channel, and by the streams and rivers which flow into it on the mainland side'.

When the ships had sailed out of the channel, and D'Entrecasteaux was hoping to explore the immense bay to the north, the weather became so bad that he had to give up all thought of doing so, and, doubling Cape Pillar, he set sail for New Caledonia.

The journey from Tasmania was uneventful. The ships discovered new islands, corrected the observations of previous explorers, navigating at no little risk among the dangerous reefs so as to enable Beautemps-Beaupré to complete a fine series of charts, and at the same time making careful search for traces of La Perouse's expedition.

On September 6th they arrived at Amboyna, where at first the Dutch authorities objected to their landing; but the trouble was soon settled satisfactorily. There the crews found a welcome change of food, and enjoyed some weeks' rest after their long and trying voyage.

On sailing from Amboyna on October 13th D'Entrecasteaux had intended, after passing Timor, to make for Shark Bay, on the west coast of New Holland, but strong south-easterly gales carried him to the west. Cape Leeuwin was doubled on December 5th, and about 6 p.m. on December 6th the entrance to a large bay (King George's Sound) was observed. D'Entrecasteaux was very anxious to enter it, but the weather was so bad that he found it impossible to tack and make back to the entrance. Two days later he found himself in the midst of a group of small islands and reefs—the Recherche archipelago—and on December 9th was glad to anchor in Esperance Bay. There some time was spent in effecting repairs to the 'Espérance', and landing parties were dispatched to look for fresh water, the supply of which had become very low; this search, however, proved a failure. The admiral noted in his diary how poorly supplied with fresh water the south coast of New Holland seemed to be.

The expedition was further delayed by Riche, the naturalist, who was lost for more than two days through his own carelessness and disobedience. The account of his experiences, and how he followed some aborigines whom he saw (fortunately, perhaps, for him he failed to overtake them), is interesting reading, as he describes the various animals, birds, plants, &c., which he met with. Although Riche fully acknowledged himself in fault, and expressed his gratitude for all the care which was taken for his rescue, La Billardière seized this opportunity to launch accusations against the commander in the book which he subsequently published. However distinguished La Billardière may have been as a scientist, his criticisms of his officers and companions was so unfair and spiteful that little credence can be placed in them.

On leaving Esperance Bay the expedition sailed slowly along the southern coast as far as 130° of longitude, when on January 2nd Huon de Kermadec signalled that the 'Espérance' had barely enough water to last her a few days, and that her rudder was in need of repairs; next day, receiving further unfavourable reports from the 'Espérance', and knowing that the water supply of the 'Recherche' was getting low, the admiral decided to make a course for Van Diemen's Land. After a somewhat stormy passage the expedition arrived at South Port on January 21st, 1793, and proceeded to anchor in Rocky Bay; the 'Recherche', keeping too close to the eastern shore, took the ground lightly, but had no difficulty in getting afloat without any damage. It was during this passage that D'Entrecasteaux, from the observations made of the westerly currents, formed the opinion that Van Diemen's Land was an island, and that a strait existed between it and New Holland; he records in his journal that it is his intention later to sail to Point Hicks in order to verify his supposition.

At South Port twenty-two days were spent repairing the ships and laying in a supply of wood and water, while La Billardière and the other scientists made valuable collections of plants, fishes, and animals. While charmed by the country, D'Entrecasteaux complains of plagues of blowflies, which set up putrefaction in all kinds of food, while their buzzing was loud and annoying. He had experienced nothing like them in other parts of the world.

De Welle and Beautemps-Beaupré sailed up the Huon for more than three leagues; they described it as more than one and a half miles wide at its mouth, its course being to the north-west for about 7 miles, then to the north some degrees east for 5 miles. At the bend of the river they found the river covered with swans, which made no attempt to escape from the boat, even when shots were fired at them point-blank. Port Cygnet also was visited and examined by these officers.

Sailing slowly through the channel, both ships, after passing Satellite Island, grounded near Point Riche, but floated off as the tide rose. The same two officers landed on Bruny Island, where, under the direction of Beautemps-Beaupré, a base was measured on the isthmus in order that exact surveys might be made.

On the 14th February Captain Huon de Kermadec was ordered to send a boat to examine North-West Bay, while Willaumez was dispatched to explore the deep inlets at the bottom of Storm Bay, which the admiral had noticed the preceding year.

Accompanied by Beautemps-Beaupré and provisioned for four days only, Willaumez, on issuing out of the channel, kept to the western side, and entering what he at first thought was an arm of the sea found himself in the mouth of a large river, Rivière du Nord, in contrast to the Rivière du Sud (River Huon). This river, which we now call the Derwent, he ascended for some four leagues, and then returned.

On leaving the Derwent Willaumez kept to the eastern shore, and examined Double Bay (Ralph's Bay); as he coasted along he passed between the mainland and the island called by the French, Willaumez Island, after this distinguished sailor, but now known as Franklin Island, and entered the large bay, to which he gave the name of Baie du Nord (Frederick Henry Bay). By the time he reached the ile Saint Aignan (Slopen Island) food supplies were almost exhausted, but the goodwill of the crew and their readiness to go on low rations encouraged him to persevere. Unfortunately bad weather came on, compelling the boat to run for shelter under a cape (Point Renard)[1], and as there was no improvement next day he had to abandon the attempt to make for East Bay Neck, which was close at hand.

The admiral's instructions had been to discover whether a channel existed, and whether the Maria Islands of Captains Cook and Furneaux were really islands or only a peninsula. Willaumez reported that, although the country was so broken up that a passage might have escaped his observation, he saw land to the east, which made him think that no such channel existed.

The continued absence of this boat and the strong gales which had raged for two days caused the admiral such uneasiness about the safety of his men that he dispatched the 'Espérance' through the D'Entrecasteaux Channel in order that she might send out search parties; fortunately on the fifth night after its departure the boat returned, the crew being exhausted and chilled to the bone.

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[1] Point Renard was named after Surgeon-Major Renard, of the 'Recherche'.

Willaumez, although he had failed to discover the supposed channel, described a great series of bays extending in the north to 42·42° and in the east to the meridian of Cape Pillar. 'It seems', says D'Entrecasteaux, 'that all the sheltered havens of New Holland are collected together in the neighbourhood of South Cape, to the east of which are to be found an uninterrupted range of harbours, ports, and bays, which form one vast haven eighteen by fourteen leagues in extent. I do not believe that there is in any part of the world such a great number of excellent anchorages assembled in so small a space'.

On February 21st, 1793, the two ships sailed for Fleurieu (or Oyster) Bay, but were driven by the weather to put into Adventure Bay, which they quitted on February 27th, sailing along the east coast as far as Cape Frederick Hendrick, after which they steered a course for New Zealand.

No landing was made there, and on March 23rd the ships anchored at Tongatabu, in the Friendly Isles, staying there for more than a fortnight. Passing the New Hebrides, they arrived on April 18th at Balade, on the east of New Caledonia, the survey of which the admiral wished to complete; the chart of this coast by Beautemps-Beaupré D'Entrecasteaux describes as one of that scientist's best pieces of work. There they spent nearly three weeks, their stay being saddened by the death of Captain Huon de Kermadec, who had been in bad health for some time. D'Entrecasteaux, who was a personal friend of many years' standing, reproaches himself in his diary for having persuaded de Kermadec to come on this expedition, as his constitution had been much weakened by his long and trying service in the navy, and pays a touching tribute to his character. They buried him at nightfall on the little island of Bouguioue (Observatory Island), no mark being placed on his grave because of the fear that the savages, who were cannibals, might disturb his body. Some years later a cross was erected there by the 'Heroine', a French corvette. This was removed in 1847, as the mark was found to be confusing to navigation, but in 1857 Captain Ville Georges and Dr. Viellard built a small monument of coral on the spot.

D'Entrecasteaux, in his journal, comparing the two islands of Van Diemen's Land and New Caledonia, writes as follows: 'New Caledonia, lying in the tropics and enjoying a most beautiful climate, presents a coast-line bristling with nothing but rocks, and unapproachable. Van Diemen's Land, placed in a high southern latitude, possesses the most magnificent roadsteads and the safest of havens. They are, so to say, the two extremes of good and evil. If we ought not to hope to find as fine harbours as those of Storm Bay, we should flatter ourselves that we shall not encounter a coast as dangerous as that of New Caledonia'.

The impression that the natives of New Caledonia made on the explorers contrasted very strongly with the sentiments which they had formed for those of Van Diemen's Land. The latter, D'Entrecasteaux says, 'offer the most perfect image of a primitive society, where men are not troubled by passion nor corrupted by the vices of civilization; assured of easily finding their sustenance, they enjoy peace and contentment; their open and smiling physiognomy represents a happiness which is troubled neither by importunate reflexions nor by vain desires. The New Caledonians, more advanced doubtless in civilization, have a ferocious character, and are constantly at war with one another. Many of them had recent wounds on their bodies, and the human flesh we saw them eating, which must have been that of their enemies, showed that fighting was of recent date'.

On May 9th D'Auribeau took command of the 'Espérance', and Rossel became flag captain of the 'Recherche'.

As they directed a course toward the archipelago of Santa-Cruz a group of three small islands was observed, one of which, situated to the east, had not been perceived by Carteret. 'We called it "Ile de la Recherche", but we saw it at such a distance that we could not place it on our chart with precision, although we noted its latitude and longitude within some minutes of accuracy', says D'Entrecasteaux. This was the very spot where La Perouse was shipwrecked, as was discovered by Dillon and D'Urville many years later; it is now called Vanikoro. It seemed the irony of fate that led D'Entrecasteaux to give the name of Ile de Recherche to the very island where the French explorer whom he failed to find had been lost.

Pursuing his investigations in Santa-Cruz and the Solomon Group, he could gather no information from the natives of these islands, nor from those of the Lousiades, where he discovered and named some new ones after Rossel, Saint-Aignan, Trobiand, and Riche. A gulf on the south-east of New Guinea he named 'Huon Gulf'.

On June 29th the ships passed through Dampier Strait, and close to the coast of New Britain observed the eruption of a volcano in the sea. By this time the stock of provisions on board was getting low, the wine had become sour, the flour had rotted, the health of the crew was bad, and scurvy was prevalent, so that the admiral decided to sail for Java, which it was becoming daily more urgent for them to reach.

D'Entrecasteaux himself was in a serious condition, suffering from scurvy and dysentery, and on July 8th he became too ill to write his journal, which was continued by Rossel. On the day before his legs had become very swollen, and black spots, which appear towards the end of the disease, had developed. 'We were hoping', says Rossel, 'to land him, for we felt that a rest ashore would do more than anything to restore his health. He refused all our requests, replying that he would never for the sake of his personal benefit depart from the orders which had been given him in his letters of instruction, that the objects of general utility, and, above all, the interests of the State, must never be sacrificed to private affairs. During the night of July 19th the pain became so violent and caused him such suffering that we perceived the onset of delirium; medicine proved useless. Towards mid-day the alarming symptoms seemed to abate, and we began to flatter ourselves that there might be some hope; but it was not of long duration. He, whose existence had been so precious to us all, became comatose, and died at half-past seven on the night of July 29th '. He was buried with naval honours next day.

Rossel says of him: 'D'Entrecasteaux astonished the most experienced sailors by his boldness in braving the greatest dangers; a boldness which, while it might have passed for rashness in another, was justified in him by the resources of his sound, keen, fertile intellect: the danger which might have taken an ordinary man by surprise was always provided for in his plans, so that the result proved that he could defy it, inasmuch as he was sure of overcoming it '.

Admiral Jurien de la Gravière, who was then a young officer on the 'Espérance', tells how all were overcome with grief and stupor at the news of the death of a commander who was so respected, so beloved, so humane.

After his death nothing but misfortune befell the expedition. On August 20th D'Auribeau took command on the 'Recherche', and Rossel was transferred to the 'Espérance'; but the former, whose health was bad, entrusted Rossel with the duty of bringing the ships to the island of Bourou, where they were provisioned, and where they remained from September 3rd to September 15th. Arriving at Batoum on October 9th, they stayed for forty-eight hours in order to obtain a further supply of fresh food, scurvy and dysentery raging amongst the men, whose sufferings were accentuated by the great heat which prevailed. D'Auribeau, who had again resumed supreme command, brought his ships to anchor in the harbour of Sourabaya on October 19th. The Dutch authorities at first refused them the hospitality of the port, so that after being kept waiting for some days the high command had decided to sail for the Ile de France, notwithstanding the fact that so many of the crew were incapacitated by illness. The reason given by the authorities was that war had now been declared between Holland and the French Republic, the Dutch disregarding the fact that letters of safe conduct had been issued to the expedition on its departure on a voyage of exploration. At the last moment, however, the Council at Batavia announced that they would grant to the French ships the privileges belonging to friendly nations. This permission was subsequently withdrawn and again restored.

In addition to the sufferings of the expedition from famine and disease there was now to be added the political trouble and strife engendered amongst its members by the revolution and the execution of Louis XVI. Two parties were formed: the Royalist group, which included most of the officers, many of whom were of the old noblesse; and the Republican, which embraced most of the scientists, like La Billardière, Riche, and others, who had been ardent encyclopaedists. The crews took little or no part in the dissensions; knowing that they were under the command of brave officers they did their duty loyally as sailors of the navy of France.

After the American War of Independence, in which it had distinguished itself, the French navy was in a high state of efficiency, both as regards ships and personnel, and France might have once more contested the empire of the sea. At the Revolution, however, many of her best officers and sailors, being of royalist sympathies, were driven from the service, and the navy was brought into such a state of chaos that even Napoleon himself failed to restore its ancient prestige. It was this loss which accounted largely for the failure of the French navy in the Napoleonic wars.

While D'Entrecasteaux lived his genius, and the respect and affection in which he was held by all, prevented any quarrels between members of the expedition. D'Auribeau was of a different temperament; he was of arbitrary disposition, and was feared and disliked; possessed, as Jurien de la Gravière says, of an ungovernable pride, he was totally unfitted for supreme command. He had no sympathy for modern ideas; he disliked the scientists being on board his ship, and was very annoyed with them when they installed their breadfruit trees on his quarter-deck.

With the permission of the Batavian Government, officers and crew began to live ashore. They were able at first to pay their way by selling the merchandise which they had brought with them for barter; when this money was spent they borrowed from the Dutch Trading Company on the security of their pay, which had been accumulating for them in France for more than two years. Soon, however, French credit had ceased to exist, and the Batavian Government took possession of the ships as a guarantee for the borrowed money. By this time the morale of the expedition was being sapped by the idle life ashore; quarrels became more frequent, the staffs ceased dining together, each went his own way. To make matters worse D'Auribeau seized the opportunity to confer the Cross of Saint-Louis on three of the officers, at the same time demanding the oath of fidelity to the King. With the connivance and support of the Dutch authorities the two corvettes were surrounded by men-of-war with loaded guns, lists of proscription were drawn up, detachments of troops made prisoners of the men ashore, and the white flag was hoisted and saluted. This day, February 20th, 1794, may be considered as the end of the expedition. The officers who were not royalists, the savants, and the naturalists were detained in fortresses, while half the crew were sent as exiles into the interior of Java, where many succumbed eventually to fever and dysentery. Of the original 219, 99 died. Jurien de la Gravière and his friend Beautemps-Beaupré were included in the proscription, but were afterwards released at the request of D'Auribeau. Fortunately the hospitality of the Dutch settlers allowed the victims of this *coup d'etat* to endure their captivity in comparative comfort, and soon the news of French victories—the English, under the Duke of York, beaten at Hondschoote, the Austrians at Wattignies and Fleurus, Belgium reconquered, Holland invaded—completely changed the outlook. In 1794 D'Auribeau died at Samarang and two officers at Batavia, while two others joined the Dutch navy, which was now a friendly power, Holland having become the Batavian Republic, an ally of France against England.

Rossel, accompanied by the remaining officers, sailed from Java in January, 1795, on board a Dutch convoy, arriving at Table Bay on the 4th of April, where Jurien de la Gravière transhipped from the 'Dordrecht' to the 'Hougly' in order to rejoin Rossel, who was carrying with him all the papers, charts, and reports of the expedition. While his commander was ashore the 'Hougly' sailed unexpectedly with Jurien de la Gravière and de Trobiand on board. Rossel had to take passage by a brig-of-war, which was captured near the Shetlands, and he himself was taken to London as a prisoner. In the meantime the 'Hougly' was seized near Saint Helena by an English squadron under Commodore Essington, who took possession of all the papers, charts, and collections of the expedition, notwithstanding the formal protests of the French officers, and in violation of the pledges of neutrality and safe conduct furnished by the English Government in 1791.

There is no doubt that the value of D'Entrecasteaux's papers and charts were recognized by the English Government, and that they made use of them later for the expeditions which they sent to Australia and Tasmania. They learned from him his opinion that Tasmania was an island, and it was following his indications that Bass and Flinders made their discoveries. Bruni Island, D'Entrecasteaux Straits, the Huon, the Derwent, in fact most of the south coast of Tasmania, was French by discovery. The Home Government realized this, and foresaw the probable claims by France; to cut short all doubt, therefore, the Governor of New South Wales dispatched a detachment of troops in 1803, who hoisted the British flag, and took possession of that land by the Derwent River which Willaumez had discovered 10 years before.

After the Peace of Amiens, in 1802, the papers were returned to Rossel, and the collections of natural history were restored, so La Billardière tells us, through the generous intervention of Sir Joseph Banks with the Government.[1]

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[1] La Billardière's collection consisted of 22 boxes, containing specimens of plants, flowers, insects, fish, reptiles, birds, small kangaroos, and mineralogical specimens.

The bread-fruit trees which had been collected by the expedition in the Friendly Isles were taken eventually to Batavia; La Haye transported them to the Ile de France in 1797, where some were placed in the botanical gardens and multiplied. Many of these were distributed to other colonies, while some of the original trees were taken to Paris by La Haye.

During their two visits D'Entrecasteaux and the members of his expedition had frequent meetings with the Tasmanian natives, and were on the most friendly terms with them. He and La Billardière have left long accounts of them, their character, and customs, much of which Ling Roth quotes in his book on the aboriginals of Tasmania. A vocabulary of their language was also compiled.

Huon de Kermadec (Jean Michel) was born at Froment, near Brest, on September 12th, 1748, the descendant of an old and noble family of Brittany, whose chateau near Landerneau dated from 1270 A.D. Many of the members of this family had served in the French navy. He was admitted as a page into the royal household in 1762, and into the navy four years later. As ensign on the 'Sensible', he fought, as did his uncle, in the battle of the Ushant; as lieutenant he served under the Comte d'Estaing at the capture of Grenada and the siege of Savannah, and with Motte-Picquet against Cornwallis. Knight of Saint Louis in 1781, he sailed under D'Entrecasteaux in his well-known voyage to the Indian and China seas. On his return he was made a member of the Royal Academy of Marine, and read before that body his journal of the voyage. Chosen by D'Entrecasteaux as his second in command of the expedition which was fitted out to search for La Perouse, he was promoted to the rank of post-captain. He died on the 6th of May, 1793, at Balade, in New Caledonia.

In Tasmania the Rivers Huon and Kermandie (corruption of Kermadec) bear his name; some small islands to the north of New Zealand and a bay in New Guinea were also named after him.

Several members of this old family, Comte Reges de Kermadec, Colonel de Kermadec, and others are still living in France; a small miniature of Huon as a child is in the possession of a relative.

Rossel (Elizabeth Paul Edouard) was born at Sens on September 11th, 1765, entered the navy in 1780, and served in the Antilles under the Comte de Grasse. Attached to D'Entrecasteaux in 1789, he so perfected himself in his profession that he was promoted lieutenant in 1789, and chosen for the expedition of 1791. On the death of De Kermadec he succeeded D'Auribeau in the command of the 'Recherche'. The death of the admiral, followed later by that of D'Auribeau, placed him in supreme command. As his vessels were still detained by the Batavian Council of State, Rossel sailed on a Dutch vessel, taking with him all the papers and plans of the expedition. Captured by the English north of Shetland, and taken to London as a prisoner of war, he was released after some months. He was so overcome, however, by grief and horror at the murder of his mother on the guillotine that he did not return to France until the Peace of Amiens. At the request of Napoleon he edited and published the account of D'Entrecasteaux's expedition. He subsequently published a book on nautical astronomy, which was translated into several languages; in 1812 he was elected a member of the Institute of France, the Legion of Honour was conferred on him in 1822, and he was gazetted rear-admiral on his appointment as Director of the Department of Charts and Plans of the Navy.

In addition to the works mentioned, he published many other scientific treatises, and was one of the founders of the Geographical Society of France. Rossel was an artist of great distinction, and painted many pictures representing naval scenes and episodes, some of which are to be found in the museum of Versailles and in the Ministry of Marine at Paris. He died on November 20th, 1829.

Beautemps-Beaupré (Charles François) was born on August 6th, 1766, at Neuville-au-Pont, and studied under his relative Nicolas Buache, who was Geographer-Royal. At the age of 19 he was entrusted by the Minister of Marine, the Comte de Fleurieu, with the work of drawing the charts of the 'Neptune'. In D'Entrecasteaux's expedition he distinguished himself not only by his astronomical and geometrical observations and discoveries, but by the exactitude of his charts. Returning to France in 1796, he continued his work, and published the atlas of D'Entrecasteaux's voyages in 1807.

Napoleon, recognising his talent, entrusted him with the hydrographic survey of the French coast, the North Sea, the Adriatic, &c.

From 1816 to 1833 Beautemps-Beaupré continued his work, producing the French 'Pilot', a magnificent atlas in six volumes, which put all other charts out of date because of the precision of its astronomical, geodesic, and nautical observations. He also collated and corrected on a very large scale the whole of the charts of the French coasts in 527 volumes, which are deposited in the archives of the French navy. His pre-eminent work for navigation won for him from his English confreres the title of 'The father of hydrography'.

He was named Knight of Saint Louis and of Saint Michael, Grand Officer of the Legion of Honour, member of the Department of Longitudes, and his bust was placed in the great gallery of the Department of the Navy by command of the Emperor Napoleon III. two years before his death in 1854.

Willaumez (Jean Baptiste) was born on August 7th, 1763, at Palais, in Belle-Isle, the son of a coastguard officer. Left a penniless orphan, with five younger brothers, he educated them for the navy, in which service they all lost their lives. Embarking at the age of fourteen as a pilot's apprentice on the 'Bien-Aimé', commanded by Bougainville, he rose rapidly, until in 1781 he was pilot on the 'Amazon', commanded by La Perouse, who put him on board with a prize crew, to take to Lorient an English ship which he had captured. In 1783 a frigate of 32 guns in which he was serving was taken by the English 'Saint Margaret', of 44 guns, but next day was retaken by the French. Willaumez, who had received two severe wounds in the fighting, was promoted to the rank of senior pilot, although he was then only 19 years of age. Skilled in the practical part of his work, he wished to perfect himself in theory, and studied nautical astronomy and mathematics with this end in view; but he would probably never have become a commissioned officer had it not been for the Revolution, which in 1791 made him an ensign.

In the expedition of D'Entrecasteaux he was made a navigating officer, and the admiral promoted him to lieutenant, conferring on him the Cross of Saint Louis at a later date.

When the French ships were seized by the Dutch at Sourabaya, Willaumez was detained for some time, but eventually, with some of his companions, made his way to the Ile de France, which was then being blockaded by an English squadron. The French, sailing out with two frigates, defeated the English, and raised the blockade. Willaumez, who had been again wounded, was entrusted with the duty of carrying dispatches to France. Promoted post-captain in 1795, he was engaged in almost continuous fighting, and captured nineteen English ships in all. Officer of the Legion of Honour in 1805, and rear-admiral, he commanded a light squadron, and with a smaller ship fought the English three-decker 'Hibernia', commanded by Lord Cornwallis. After serving at the Cape and the West Indies he returned to Europe. Vice--admiral in 1819, Knight of Saint Louis and Grand Officer of the Legion of Honour, he was made a peer of France and given the title of Comte. He died in 1845.

He was the discoverer of the River Derwent and the various bays at its mouth. It is a matter of regret that his name is unknown and unremembered in the place which he discovered and charted.

Jurien de la Gravière (Pierre Roch) was born on November 5th, 1772, at Gannat, and joined the navy at the age of 14 years. Volunteering for D'Entrecasteaux's expedition, he was made ensign on the 'Espérance'; surviving the tropical diseases which carried off so many of his companions, he was taken prisoner when the Dutch ship on which he was returning to France was captured by an English man-of-war near Saint Helena. On his release he rejoined the navy, in which he gained rapid promotion, becoming post-captain in 1803. In command of three frigates, he defeated an English squadron of six ships at Sables d'Olonne, in 1809, after three hours' hard fighting. Subsequently he wes sent to retake possession of the Ile de Bourbon. Rear-admiral in 1817, vice-admiral and peer of France after the July revolution, he had conferred on him the honour of the Grand Cross of the Legion of Honour. He died in 1849. He published an interesting book of memoirs—'Les Souvenirs d'un Amiral'.

Amongst the crews of the two ships were three interesting people, the brothers Raoul, and the purser of the 'Recherche'.

The elder brother, *Raoul (Joseph François)*, was born at Tréguier in 1766; joining the navy as a ship's boy he soon saw active service. Pilot on the 'Recherche', he discovered the island (29 S. latitude, 179 E. longitude) to which his name was given. Taken prisoner and detained in Batavia, the Cape, and England, he rejoined the navy in 1796 with the rank of ensign, and served in the expedition to Ireland. In the terrible fighting of 1798 he received seven severe wounds and lost his right eye, and for the second time was made prisoner. On his regaining his liberty he was, in 1799, promoted to the rank of lieutenant, and employed in the depot of charts and plans. Commander on the 'Imperial' in 1804 at San Domingo, he received three more severe wounds; at Guadeloupe he captured an English vessel; and despatched on a mission to Java on the 'Medusa' he defeated and captured the 'Bellona', which lost 72 men. Post-captain in 1812, he took part in the bombardment of Antwerp, and died in 1816 while on active command. His service record showed seventeen wounds and the loss of an eye.

Cape Raoul, on the south-east coast of Tasmania, was named after this gallant sailor.

His younger brother, *Raoul (Ange-Aimé-Marie)*, was born in 1769, and shared with his brother in the hydrographic work of the expedition under the direction of Beautemps-Beaupré. Ensign in 1797, lieutenant in 1803, he was attached to the general depot of the Marine in 1815, and continued to work under Beautemps-Beaupré. He died in 1843.

Girardrin (her real name is unknown), the purser of the 'Recherche', was the first white woman to visit Tasmania, and probably the first to visit Australia.

Her story was as follows: She was the daughter of a respectable merchant of Versailles, and having been seduced by some lover fled from her father's anger. Abjuring her sex, and dressed as a man, she managed, by means of a letter of recommendation, which she obtained from the sister of Captain de Kermadec, to obtain the position of purser. She was most attentive to her duties, but kept apart as much as possible from the rest of the crew, and resented any familiarity. On one occasion a young volunteer teased her on account of her hairless face, and said jokingly that she must be a woman; considering herself insulted, she challenged him to a duel, and fought bravely, receiving a wound in the forearm. Notwithstanding the fatigues, the bad food, the scurvy, and the dysentery which laid others low, she not only kept on duty, but took an active part in nursing her sick comrades. She was left with Jurien de la Gravière and de Longuerue, the last of the expedition to sail for France. De Longuerue, whom she nursed, succumbed; then she herself fell sick and died, her death being as stoical as had been her life. The night before she died she told Jurien the whole history of her life.

LIST OF OFFICERS, SAVANTS, AND ARTISTS OF THE FRIGATES 'LA RECHERCHE' AND 'L'ESPÉRANCE', COMMANDED BY M. D'ENTRECASTEAUX

'La Recherche'

BRUNI D'ENTRECASTEAUX, rear-admiral

Lieutenants

D'HESMIVY D'AURIBEAU, made post-captain
DE ROSSEL
DE CRETIN
LA FRESNAYE DE SAINT AIGNAN
SINGLER DE WELLE
WILLAUMEZ

Surgeon-Major

RENARD

Chaplain

VENTENAT, canon, naturalist

Midshipmen and Volunteers

MERITE, volunteer, made sub-lieutenant
ACHARD DE BONVOULOIR, midshipman, made sub-lieutenant
DE LONGUERUE, midshipman, made sub-lieutenant
FORESTIER, made volunteer
DE LAMBERT, made volunteer
DESLACS, made volunteer

Savants, &c.

BEAUTEMPS-BEAUPRÉ, hydrographer
L'ABBÉ BERTRAND, astronomer, disembarked at the Cape of Good Hope
LA BILLARDIÈRE, naturalist
DESCHAMPS, naturalist
BIRON, draftsman
LA HAYE, gardener, botanist

‘L’ESPÉRANCE’

HUON DE KERMADEC, commander, made post-captain

Lieutenants

DENIS DE TROBRIAND
LA SEINIE
LA GRANDIERE
DE LUZANCAY
LA MOTTE DU PORTAIL
LE GRAND

Surgeon-Major

JOANET

Chaplain

PIERSON, benedictine, astronomer

Midshipmen and Volunteers *

LEIGNEL, volunteer, made sub-lieutenant
JURIEN, volunteer, made sub-lieutenant
DE BOYNES, midshipman, made sub-lieutenant
FILTZ, made volunteer

Savants, &c.

JOUVENCY, geographer
RICHE, naturalist
BLAVIER, naturalist, disembarked at the Cape of Good Hope
ELY, draftsman, disembarked at the Cape of Good Hope

The following works have been consulted in the preparation of this paper:—

Voyage de d’Entrecasteaux envoyé à la recherche de Lapérouse, par de Rossel.
Voyage à la recherche de Lapérouse, par le citoyen Labillardière.
Souvenirs d’un amiral, par Jurien de la Gravière.
Gloires maritimes de la France, par A. Doneaud et P. Levot.
D’Entrecasteaux, par Le Baron Hulot.
Personal communications from Colonel de Kermadec and others.
The Cambridge Modern History.
A History of Europe, by H. A. L. Fisher.

NOTE

In connection with the memorial to D’Entrecasteaux recently unveiled at Gordon, some controversy has taken place in the press in regard to his correct rank and name. There is no doubt about either, as documentary evidence is clear.

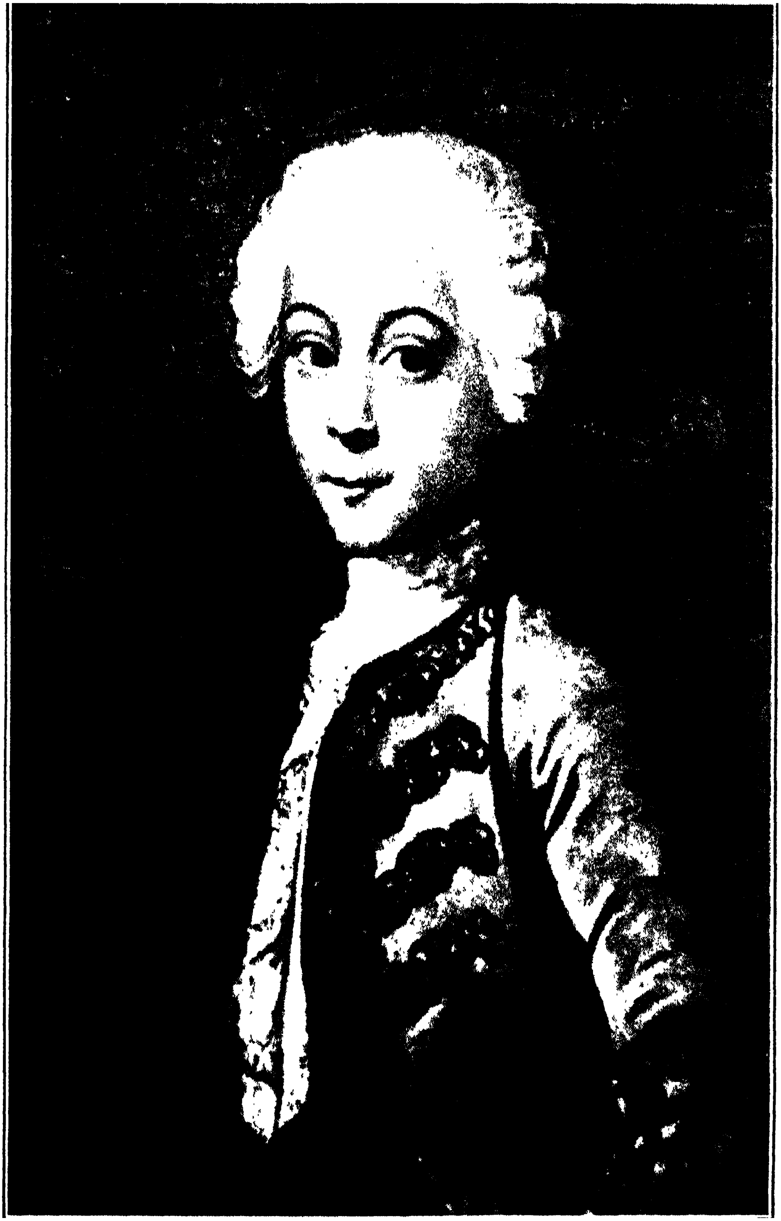
On 1st July, 1792, by command of Louis XVI., D'Entrecasteaux was gazetted a vice-admiral. There is in the transactions of La Société de Géographie, 1894, a monograph by Baron Hulot, in which D'Entrecasteaux is described as vice-admiral. The documents proving this are—

(1) Archives de la Marine, D'Entrecasteaux dossier personnel.
(2) La Liste générale des officiers de la Marine, 1791-95, année 1792.
(3) Une lettre datée de 9 Brumaire an XIII., preserved in the archives of the Ministère de la Marine, dealing with his pay as vice-admiral.

The name de Bruni D'Entrecasteaux has been written in different ways—Bruni or Bruny, D'Entrecasteaux or Dentrecasteaux. The orthography of his baptismal name and of his signature should undoubtedly be observed.

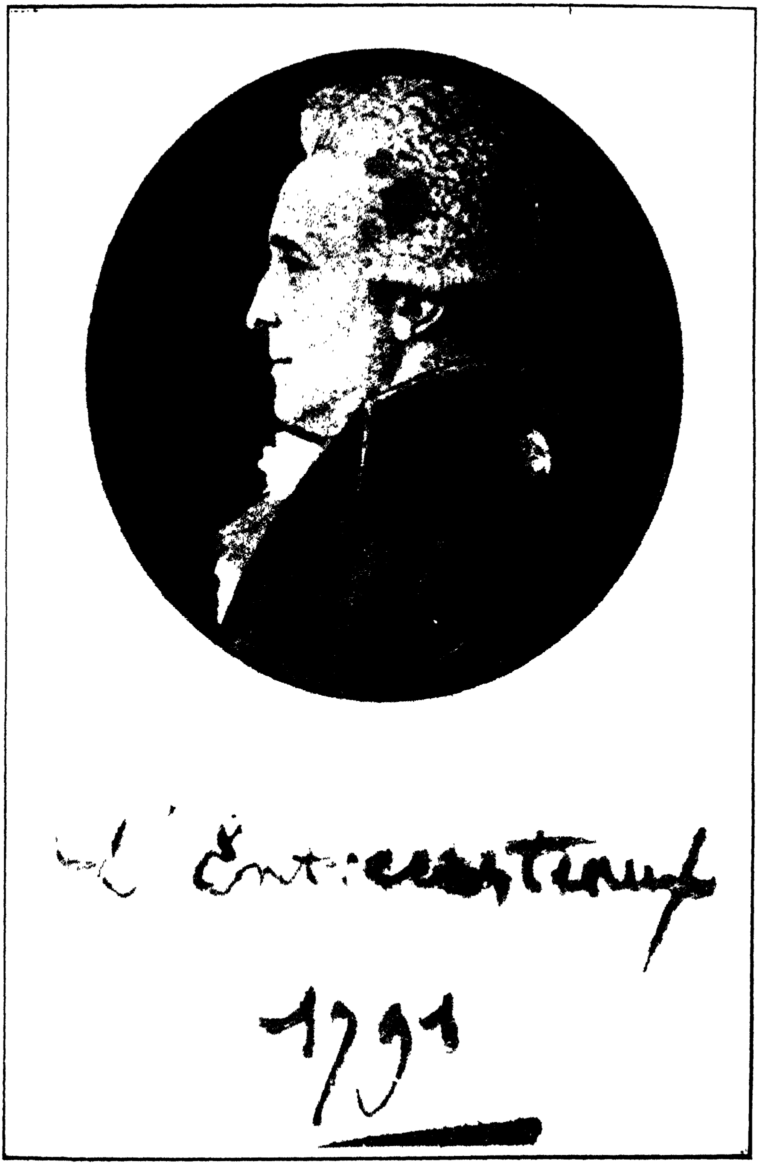
D'Entrecasteaux in his signature uses the D' (apostrophe).

His baptismal certificate, copied from the register of baptisms of the Parish of Sainte Magdeleine d'Aix, is as follows:—'Noble Antoine—Raymond—Joseph de Bruni D'Entrecasteaux, fils de messire Jean-Baptiste de Bruni, Marquis D'Entrecasteaux, Président à mortier au parlement de ce pays de Provence, et de dame Dorothée de Lestang—Parade, apres avoir été ondoyé le huit November, 1737, a reçu le supplément des ceremonies de baptème ce jourd'hui vingtième Janvier, 1738.'

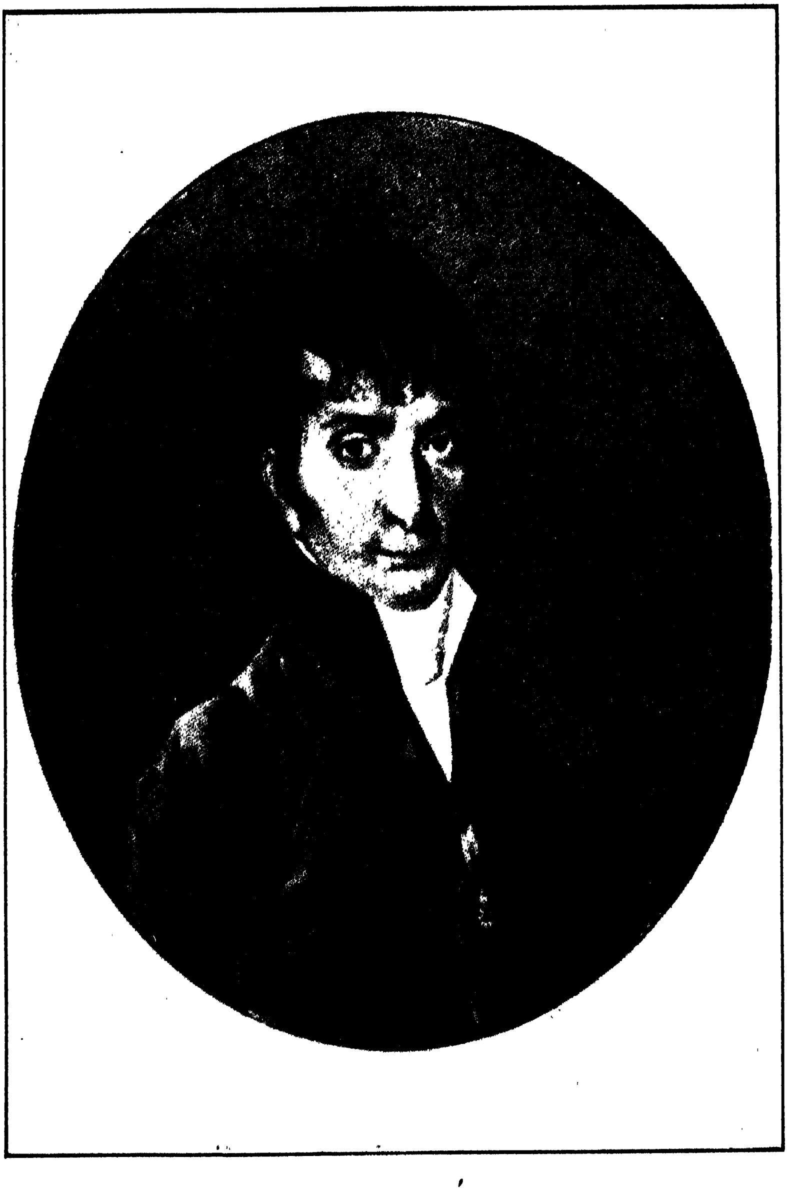


D'ENTRECASTEAUX ENFANT

LE CHEVALIER D'ENTRECASTEAUX (VERS 1774)



D'ENTRECASTEAUX (1791)



BEAUTEMPS-BEAUPRÉ (1808)

PAP. & PROC. ROY. SOC. TASMANIA, 1937 (20TH MAY, 1938)

A Survey of Eucalyptus Species in Tasmania

By

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(Read 8th November, 1937)

Plates XV-XVII

INTRODUCTION

The following notes, descriptions, and suggestions have been made in field, herbarium, and nursery work in connection with the Biological Survey of Tasmania in progress at the present time.

DIFFICULTIES OF EUCALYPT STUDY

The genus *Eucalyptus* has engaged the attention of some of the world's greatest botanical taxonomists during the past 150 years, and has been the subject of endless controversy. Some of the troubles have arisen from the following causes:—(1) The botanists who first collected in Australia and Tasmania, or who worked on existing collections, were not in possession of our modern knowledge of plant cytogenetics, and consequently could not make adequate allowance for the mutational and hybridization factors which are responsible for the high degree of species variability. Before a type description can be satisfactorily made, it is necessary to review material collected over a wide area to determine the limits of variation and the possible existence of interspecific hybridization. It may thus take several years' field and nursery experience of a group suspected to constitute a species before a safe type description can be made. Many of the early types were founded by European botanists on fragmentary and imperfect material sent from one tree only by Australian collectors. In other cases descriptions were made from trees under cultivation in Europe. This is very unsafe, as some species behave anomalously when under artificial cultivation. (2) Although during the past 30 years our field knowledge of the genus has enormously increased, workers have continued to found species on the old lines, and we have witnessed the elevation of pure hybrid types to specific rank. It is during these years that the failure to study the effects of interspecific hybridization has prevented real progress, and the difficulties have almost increased rather than diminished. It is true that in this time many true species have been discovered and the range of others extended, e.g., the recognition of *E. rubida* in Tasmania by Maiden. Work of great importance has been done by Maiden and others in describing seedlings. The influence of this is to be seen in the 'Key to the Eucalypts', by Blakely (1934). (3) The synonomy has been complicated to an inordinate degree by the fact that many of the type specimens are in the great European herbaria and are not available to Australian workers. The existence of eucalypt collections in European centres has made the question of priority a very vexed one. As an example of this note the loss of the old established name *E. amygdalina* Labill., and the change to *E. salicifolia* (Sol.) Cav. The immense size and protean character of the genus make inherent difficulties of synonomy in addition to the aggravation referred to above. Workers in the field of Tasmanian eucalypts must bear these three points in mind.

SPECIES REVIEW

The Tasmanian species have been surveyed with two objectives in view: (1) an attempt to isolate biotypes, (2) the detection of interspecific hybridization and its effect upon variability. An endeavour has been made to isolate polymorphic hybrid swarms, and determine the effect of hybridization on the origin of new eucalypt species. The term hybrid is frequently used in what follows. It is to be understood strictly in the sense of interspecific (undefined)[1] hybrid. The task of attempting to isolate Mendelian and the many other hybrid types discussed by cytolologists and cytogeneticists has not been undertaken. This is a rich field for future investigation. In the course of field work both in Tasmania and on the mainland of Australia phenomena have been noted which indicate the possible existence of Mendelian hybrids.

In 'A Key to the Eucalypts', Blakely gives 32 species for Tasmania. Of these it is claimed that *E. Huberiana* Naudin (see *E. viminalis* in check list) and *E. nitida* Hook., f., are not in Tasmania. With regard to *E. nitida*, readers are referred to the 'Critical Revision', Maiden, pt. 38, p. 235, where an incomplete description is given. Specimens collected by R. H. Cambage from near the summit of Mt. Roland are quoted in the range for Tasmania. By the kindness of Mr. W. F. Blakely I have been permitted to see one of these specimens, and have no hesitation in saying that it is *E. coccifera* var. *parviflora*. This variety is widely distributed at alpine levels in the district of Mt. Roland. A fuller description is given in 'A Key to the Eucalypts', and Risdon is quoted as a district. I have not seen the specimens on which this statement is made, but suggest that they are hybrids of *E. Risdoni* with *E. viminalis*. The former species produces two very different hybrid swarms at Risdon, one with the *E. viminalis* and the other with *E. salicifolia*.

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[1] See Darlington, 1932.

The second specimen collected by Gunn would match one of the many hybrid forms of *E. Risdoni*. In connection with this supposed species it should be noted that some of the hybrid forms of *E. Risdoni* show marked similarities to *E. coccifera* or its variety. Thirty-one species are discussed in the check-list, which includes an additional species, *E. divaricata* McAulay & Brett, sp. nov., and excludes *E. Huberiana* Naudin and *E. nitida* Hook., f.

It is suggested in this paper that the 31 species described below are composed of the following types: (1) simple or compound Linnaean species, (2) polymorphic species, (3) hybrids. The terms 'compound species' and 'polymorphic species' are used for convenience. The former is intended to describe groups which obviously contain two or more biotypes, e.g., *E. pauciflora* Sieb.; and which can be split into two or more species or varieties as the result of future investigation. The latter describes groups which are of obvious hybrid origin, including races in varying degrees of fixation. A detailed study of *E. Risdoni* and its many hybrid forms has been responsible for this suggestion (see note on *E. Risdoni* Hook., f.).

Group 1 (Simple or Compound Species)

1. *E. ovata*
2. *E. aggregata*
3. *E. globulus*
4. *E. cordata*
5. *E. viminalis*
6. *E. rubida*
7. *E. urnigera*
8. *E. subcrenulata*
9. *E. vernicosa*
10. *E. Archeri*
11. *E. divaricata*
12. *E. Gunnii*
13. *E. Perriniana*
14. *E. obliqua*
15. *E. gigantea*
16. *E. regnans*
17. *E. Sieberiana*
18. *E. salicifolia*
19. *E. tenuiramis*
20. *E. linearis*
21. *E. Risdoni*
22. *E. pauciflora*
23. *E. coccifera*

Each description includes one or more biotypes. Seedlings exhibit what may be termed normal variability for a eucalypt species as opposed to hybrid segregation.

Group 2 (Polymorphic Species)

24. ***E. Dalrympleana***
25. ***E. Johnstoni***
26. ***E. Simmondsi***
27. ***E. Tasmanica***

Each description includes a group of races which have probably arisen by hybridization, and are either fixed or are in process of becoming stabilized. Seedlings exhibit normal variation or varying degrees of hybrid segregation.

Group 3 *(Interspecific Hybrids)*

28. *E. unialata*
29. *E. biangularis*
30. *E. Irbyi*
31. *E. taeniola*

The types represent an intermediate between two biotypes, and are probably in the F_1 generation. Seedlings exhibit a high degree of hybrid segregation (see Plate XV). The trees do not form pure stands exhibiting normal variability, but are isolated and difficult to locate, and are never found outside associations of the generating species. The elevation of these hybrids to specific rank makes key compilation unnecessarily difficult. The interesting *E. globulus* × *ovata* described by Prof. A. L. McAulay in the same volume of these proceedings, Rodway's var. *Harrisoni* of *globulus (E. globulus* × *cordata), E. Sieberiana* × *obliqua*, and several other outstanding cases would equally justify specific rank.

NOTE ON EUCALYPTUS RISDONI HOOK., F.

(See also *E. Risdoni* Hook., f., in the Check-list)

No eucalypt species presents more difficulty than *E. Risdoni* Hook., f., and its var. *elata* Benth. (*E. Tasmanica* Blakely). To understand the problems associated with it the following points, summarizing its history and opinions held by different botanists with regard to it, should be noted:—

(1) The type was described by Hooker (1847) on material from Risdon, and is beautifully figured in his 'Flora of Tasmania'. It is intended to cover the trees which maintain entirely opposite foliage.

(2) Bentham, writing later on the same species, extended the description to include the trees which are practically entirely covered with opposite foliage but carry a few alternate leaves.

(3) Mueller united *E. Risdoni* Hook., f., with *E. salicifolia* Cav. (*E. amygdalina* Labill.).

(4) The type has a very limited distribution (see check-list).

(5) The protean complex of forms which pass rapidly from the opposite to the alternate leaf stage, and often assume the dimensions of large trees, has a wide distribution.

(6) This was identified by Hooker as *E. radiata* Sieb. He described and distributed five varieties of it.

(7) Bentham described in the 'F. Aust.' the same complex as *E. Risdoni* Hook., f., var. *elata*. It went under this name until the species *E. Tasmanica* was founded by Blakely (1934).

(8) Rodway supported the view that *E. Risdoni elata* is simply *E. Risdoni* Hook., f., in better soil conditions than obtain at Risdon.

(9) On the basis of oil determinations Baker and Smith (1912) united *E. Risdoni* Hook., f., with its variety *elata* and the variety *hypericifolia* of *E. salicifolia (E. amygdalina)*. at one time regarded by Rodway as *E. hypericifolia* R. Br.

It is suggested in this paper that Hooker's original type is the biotype, and not merely a tree prolonging the juvenile condition, and that departures from this type, slight or extensive, are due to hybridization.

The effect of soil conditions is still an open question, but in field observation I find little to support the view stated in (8). At Risdon there are trees of 20 feet or higher which have been protected from fire, and which retain the paired-leaf condition to the ultimate branchlets; they give every sign of flourishing just because they are in patches of better soil than exists in the average portion of the stand. The soil conditions on the upper side of the Huon-road stand of *E. Tasmanica*, as far as can be judged from the road-cutting, are little, if at all, better than those at Risdon. The trees at Risdon have been destroyed by fire at least once, as many of them grow mallee fashion from blackened root stocks. In the middle of this stand it could be said that umbels in the opposite leaf stage is the most characteristic condition. A similar stand of *E. Tasmanica* Blakely exists on mudstone near Cambridge, on the southern edge of the *E. Risdoni* distribution. There is the same destruction of the original stems as at Risdon, but very few umbels can be found in the opposite leaf stage. It is difficult to account for this on soil conditions alone. The tendency to flower in the opposite leaf stage has apparently vanished when we go as far south as the mudstone flats on the top of Tasman's Arch. It is significant that the districts south of Cambridge represent some of the oldest well-settled areas, and would probably contain an abundance of introduced insects that might aid hybridization.

The forms which connect the Risdon-Bellerive distribution with the comparatively stable types on Tasman's Peninsula show a much higher degree of polymorphism than those on the Huon-road. It must be recognised that if the lastmentioned and similar stands were created by hybridization, as is suggested below, this must have occurred long before the settlement of Tasmania. It is possible, then, that the high degree of polymorphism exhibited by the South-East Coast *E. Tasmanica* is due to secondary hybridization on what were once stable races. To support this it should be noted that *E. Tasmanica* forms segregating hybrid swarms with *E. salicifolia* near such a long-settled district as Rokeby. The attempt to deal with such polymorphism is discussed fully below.

There is no question of challenging Messrs. Baker and Smith in their opinion with regard to the identities stated in (9). The conclusion is undoubtedly correct from the point of view of an oil classification. But it is very difficult to follow them in their statement that 'the Mt. Wellington trees differ in *minor* respects only, botanically or chemically, from the smaller trees or shrubs' (at Risdon).

It is very significant that the seedlings of the opposite-leaved *E. Risdoni* are much less viable than those of *E. Tasmanica*. As far as can be judged, the latter exhibit a remarkably increased viability, that might be due to what cytologists call 'hybrid vigour'.

With regard to the taxonomy of *E. Risdoni* Hook., f., and its supposed variety *elata*, it should be noted that Hooker's attempt to see five varieties of a different species from his own *E. Risdoni* is significant. Maiden has shown that four of these varieties are var. *elata* Benth.; the fifth he thought to be an example of what is now called *E. nitida*, Hook., f. (see above). The suggestion is made in this paper that all attempts to gather these forms under one or even several species will produce results that are most misleading. A study of Plate XVI must convince any but a most prejudiced observer that to classify all these forms as examples of a single species or variety is wrong. It is evident that the description *E. Tasmanica* Blakely does not cover the complete range. The difficulty of including all the forms under one species in a key is very great. The most satisfactory guide to further investigation is to class the whole complex of forms under what I have for convenience called a polymorphic species (Group 2 above).

Mueller's view that *E. Risdoni* and *E. salicifolia* are the same indicates the serious lack of field knowledge which hampered early workers. It was doubtless arrived at by the examination of intermediate hybrid forms which connect the two species, and may be the origin of Prof. Ewart's statement quoted below under *E. Risdoni* in the check-list.

The important question of terminology must be raised at this stage. Following Cockayne and Allen, whose valuable work on hybridization in the New Zealand Flora has been an important guide in preparing these notes, polymorphic swarms of hybrid origin are represented by the symbol × preceding the generic name. The specific names are compounded of two or more words, and are intended to indicate the main generators of the swarm. Thus ×*E. Risdelata* (formed by fusing the words *Risdoni* and *elata*) represents the whole complex at present imperfectly described by *E. Tasmanica* Blakely. When a particular specific influence can be observed, the species name is fused with *Risdelata*. Thus the stand on the Huon-road referred to above is mainly ×*E. Risdo-salicilata*. Other examples are to be noted on Plate XVI. When an unknown member of the section macrantherae is apparently present, as is strongly suggested by the seedlings from many trees near to and on Tasman's Peninsula, the swarm is described as ×*E. Risdomacranthelata*. It should be noted that ×*E. Risdelata* = *E. Risdoni* × one or more species not known or stated.

At Risdon direct hybridization can be observed, as, for example, in the forms that have been classified as *E. tenuiramis* Miq. In this case the swarm would be defined as ×*E. Risdosalicifolia* (the affix *elata* being dropped). A second swarm, ×*E. Risdoviminalis*, can be observed in the same locality. Note the difference between ×*E. Risdoviminalis* and ×*E. Risdovimelata*.

These notes and terminology are given more with a view to show the lines on which investigation is proceeding, and are based upon field and nursery experience. No attempt is made here to do other than give examples and show the kind of swarm that can be isolated from the ×*E. Risdelata* complex. Descriptions will be undertaken when seedlings at present under cultivation are at a more advanced stage.

Similar polymorphic swarms to that described above as ×*E. Risdosalicifolia* exist in connection with the species of Group 3. Further investigation will be required before complete descriptions of the elements of these can be given (see Plate XV and *E. viminalis* in the check-list).

An extension of terminology is obvious. The swarm connecting *E. viminalis* and *E. globulus* can be described as ×*E. vimiglobulus*. Thus *E. unialata* Baker and Smith is suggested as ×*E. vimiglobulus* (name of author) *unialata* Baker and Smith. In these cases the second name indicates the F_1 generation, and not part of the segregating swarm. It is certain that no real progress will be possible until types such as those of Group 3 are recognised as of definite hybrid origin and future additions of the kind are rendered impossible.

SUMMARY OF SUGGESTIONS

1. *E. Risdoni* Hook., f., as originally described, is the biotype.

2. It constitutes a weak stock. Its adaptability to xerophytic conditions enables it to thrive on mudstone, where the more vigorous competing species are considerably checked.

3. Its viability has been strengthened by various stages of hybridization until in some cases stabilized races capable of producing tall, well-timbered trees have been evolved.

4. This view of the origin of *E. Risdoni* var. *elata (E. Tasmanica)* in the present state of experimental knowledge accounts

for the increased vigour as satisfactorily as the soil type theory, and better explains why *E. Tasmanica*, as well as *E. Risdoni*, is confined to mudstone formations. (One mudstone deposit cannot substantially differ from another in fertility.)

5. The hybridization may have occurred at different intervals of time. Stable races are probably of ancient origin. Such unstable polymorphism as exists on the South-East Coast may be due to secondary hybridization occurring since the settlement of Tasmania.

6. Departure from the connate juvenile leaf condition and the appearance of alternate leaves, however few, are the first indications of hybridization.

7. The multiplicity of forms thus produced cannot be satisfactorily described by Linnaean species or varieties of such species, but are best regarded as constituting a polymorphic complex, described above as a polymorphic species (Group 2).

8. A suitable terminology to describe such a polymorphic complex is suggested above.

KEY TO THE EUCALYPT SPECIES IN TASMANIA

In the present imperfect state of our knowledge it has not been possible to isolate sharply the biotypes, hence the key below allows the admission of hybrids close to the biotypes. The complex of forms described above as ×*E. Risdelata* is included for the sake of convenience under the name *E. Tasmanica*. A study of the means adopted to do this should indicate that there is a marked departure here from the case of a clearly defined simple species like *E. rubida*.

Determination has been necessary in some cases by simple statistical estimates, hence it is important to realize that imperfect material is liable to give misleading results. Due allowance should be made for colour changes in a specimen when dried. Provided suitable material is examined, it is hoped that failure to get a result on this key with the aid of the check-list indicates (*a*) an introduced species, (*b*) a member of an F_1 generation not listed in Group 3, (*c*) one of the segregating hybrids in a polymorphic swarm, (*d*) a new species.

KEY TO SECTIONS

A Anthers oblong to obovate; gland large, occupying the upper part of the connective	**Section I, *Macrantherae***
B. Average number of flowers in umbel exceeding three	**Subsection I, *Tereticornes***
BB. Umbeds one, two, or three flowered	**Subsection II, *Parallelantherae***
AA. Anthers reniform; gland small and terminal	**Section II, *Renantherae***

KEY TO SPECIES

SECTION I.—MACRANTHERAE

Subsection I.—Tereticornes.

A. Leaves ovate to ovate-lanceolate, often strongly undulate; average maximum width exceeding 2·5 cm. .... *E. OVATA* (1)

AA. Leaves lanceolate; average maximum width under 2·5 cm. .... *E. AGGREGATA* (2)

Subsection II.—Parallelantherae.

A. Umbels predominantly one-flowered, occasionally two or three flowered.

B. Leaves lanceolate to falcate-lanceolate, 10-30 x 2-9 cm., or larger, subvernicose .... *E. GLOBULUS* (3)

BB. Leaves ovate to oblong-lanceolate, 2-4 x 1·5-2 cm., vernicose .... *E. VERNICOSA* (9)

AA. Umbels predominantly three-flowered, occasionally two or one flowered.

C. Umbels axillary in opposite leaves.

D. Leaves glaucous.

E. Leaves connate at base .... *E. PERRINIANA* (13)

EE. Leaves cordate, sessile, average length less than 8 cm. .... *E. CORDATA* (4)

EEE. Leaves oblong to oblong-lanceolate, sessile, average length exceeding 8 cm. .... *E. GLOBULUS* (3)

DD. Leaves non-glaucous, vernicose .... *E. VERNICOSA*

CC. Umbels axillary in alternate leaves.

F. Average length of peduncles equal to or exceeding 13 mm.; fruit urceolate.

G. Average diameter of fruit equal to or less than 1 cm. .... *E. URNIGERA* (7)

GG. Average diameter of fruit exceeding 1 cm. .... *E. BIANGULARIS* (29)

FF. Average length of peduncles less than 13 mm.

H. Buds pedicellate, central pedicel, 1·5 mm. or longer, lateral pedicels rarely absent.

J. Valves sunk in capsule, slightly exsert or not exsert.

K. Tips of valves slightly to freely protruding. Always associated with *E. Dalrympleana* and *E. Gunnii* .... *E. IRBYI* (3)

KK. Valves completly enclosed .... *E. GUNNII* (12)

JJ. Valves not sunk in capsules.

L. Buds, fruits, mature leaves or branchlets with traces of glaucousness;[1] juvenile leaves strongly glaucous, sessile, ovate to orbicular or cordate, 2-6 x 2·5-5 cm. .... *E. RUBIDA* (6)

[1] Examination for traces of glaucousness should not be made in artificial light.

LL. Glaucousness absent in adult stage.

M. Average length of peduncles usually exceeding 5 mm.; juvenile leaves sub-glaucous to glaucous, sessile, oblong-ovate to ovate or cordate, 4-6 x 4-5 cm. or larger; sometimes stem-clasping .... *E. DALRYMPLEANA* (24)

MM. Average length of peduncles 5 mm. or less; juvenile leaves not glaucous in the type, sessile, oblong to oblong-lanceolate, 5-10 x 1-3 cm. .. .. *E. VIMINALIS* (5)

HH. Buds sessile, or lateral buds sessile, with central pedicel equal to or less than 1·5 mm., or all buds with pedicels equal to or less than 1 mm.

N. Maximum diameter less than the altitude of the fruit.

O. Calyx tube obconical to sub-cylindrical, fruit sub-urceolate to urceolate, buds, fruits, and branchlets usually glaucous .. .. *E. DIVARICATA* (11)

OO. Calyx tube cylindrical or ovoid, fruit campanulate to ovoid-truncate, glaucousness absent in the adult stage .. .. *E. ARCHERI* (10)

NN. Maximum diameter equal to or exceeding the altitude of the fruit.

P. Mature leaves, buds, fruit, and branchlets usually strongly glaucous; juvenile leaves glaucous and perfoliate .. .. *E. PERRINIANA* (13)

PP. Glaucousness absent in adult stage: juvenile leaves non-perfoliate, non-glaucous or glaucous.

Q. Average ratio of length of mid-rib to maximum diameter of leaf less than 7·7; species confined to alpine or sub-alpine situations.

R. Average length of mature leaf blade exceeding 4·5 cm.

S. Average maximum diameter of mature fruit equal to or exceeding 9·5 mm. . .... . *E. JOHNSTONI* (25)

SS. Average maximum diameter of mature fruit less than 9·5 mm. .. .. *E. SUBCRENULATA* (8)

RR. Average length of mature leaf blade equal to or less than 4·5 cm. ... . *E. VERNICOSA* (9)

QQ. Average ratio of mid-rid to maximum diameter of leaf equal to or exceeding 7·7; not found in alpine or sub-alpine situations, and always associated with *E. globulus* and *E. viminalis* .. .. *E. UNIALATA* (28)

Section II.—Renantherae: Umbels, with the exception of the three-fruited *E. coccifera*, averaging more than three flowers.

A. Midrib bisecting the greatest width of the leaf or nearly so.

B. All or some leaves with semi-longitudinal venation.

C. Peduncles strap-shaped.

D. Average length of peduncles usually equal to or exceeding 12 mm., mature leaves vernicose; average maximum width of leaves usually equal to or exceeding 17 mm.; fruit pyriform to falcate-pyriform, pinnately veined leaves absent ... . *E. SIEBERIANA* (17)

DD. Average length of peduncles usually less than 12 mm., mature leaves sub-vernicose; average maximum width of leaves less than 17 mm.; fruit sub-pyriform to ovoid-truncate, pinnately veined leaves often present; always in association with *E. Sieberiana* and *E. salicifolia* . . *E. TAENIOLA* (31)

CC. Peduncles terete to angled.

E. Average length of peduncles exceeding 8 mm., juvenile leaves opposite for three to five pairs, bark smooth to base *E. PAUCIFLORA* (22)

EE. Average length of peduncles equal to or less than 8 mm., juvenile leaves opposite for a large number of pairs; bark rough on the stem, upper branches smooth *E. SIMMONDSI* (26)

BB. Veins pinnate, a few at the base sometimes with a longitudinal tendency, or venation of mature leaves obscure.

F. Buds and fruit non-glaucous or with minute traces of glaucousness.

G. Average maximum width of the leaves less than 1·5 cm.

H. Average maximum width of the leaves equal to or exceeding 0·5 cm.; bark rough, upper branches often smooth, with bark hanging in ribbons (seedlings raised from occasional smooth barks in this class appear to indicate hybridization) . . .. *E. SALICIFOLIA* (18)

HH. Average maximum width of leaves less than 0·5 cm.; bark smooth to base . . *E. LINEARIS* (20)

GG. Average maximum width of leaves exceeding 1·5 cm. ... . *E. TENUIRAMIS* (19)

FF. Buds or fruit, or both buds and fruit, sub-glaucous to strongly glaucous; buds smooth to costate or angled.

J. Umbels axillary in opposite leaves.

K. Alternate leaves absent from the tree; fruit pyriform-truncate; top of capsule sub-concave to concave .. .. *E. RISDONI* (21)

KK. Majority of leaves on adult tree alternate; fruit turbinate to sub-globose, or sub-pyriform to pyriform truncate; top of capsule convex to flat, or sub-concave to concave . . .. *E. TASMANICA* (27)

JJ. Umbels axillary in alternate leaves.

L. Buds sessile, tapering at the base in the larger fruited types to give effect of a peduncle; operculum flat or concave, without any well-defined point, or rarely sub-acute.

M. Umbels 3-6 flowers ... ... *E. COCCIFERA* (23)

MM. Some umbels with more than 6 flowers *E. TASMANICA* (27)

LL. Buds pedicellate: umbels 6-25 flowered; operculum more or less convex, acute, or obtuse, smooth or warty ... ... *E. TASMANICA* (27)

AA. Midrib not bisecting the greatest width of the leaf.

N. Fruit pyriform; disc oblique; valves not protruding, more or less deeply enclosed by the disc; average diameter of mature fruit exceeding 7 mm.

O. Glaucousness to sub-glaucousness present on buds, fruits, and mature leaves or branchlets; old fruit and branchlets pruinose; juvenile leaves glaucous, oblong-ovate to oblique lanceolate ... ... *E. GIGANTEA* (15)

OO. Glaucousness absent in the adult and juvenile stages; branchlets not pruinose, old fruit green or brown ... ... *E. OBLIQUA* (14)

NN. Fruit obconical to sub-pyriform; disc flat to sub-oblique, usually 1 mm or less in width; valves enclosed by the disc, and often slightly protruding; average maximum diameter of mature fruit 7 mm. or less ... ... *E. REGNANS* (16)

CHECK-LIST

The descriptions below are concerned not with the complete range of a species when that extends beyond the State, but only on the Tasmanian forms. The greatest assistance has been gained from 'A Key to the Eucalypts'. Eucalyptography owes a great debt to W. F. Blakely for this pioneer work. The form of the descriptions follows the excellent example set by Blakely; every measurement has been checked, and departures from the estimates and descriptions given in the above work have only been made when necessary. In some cases these are substantial, e.g., *E. rubida* is quoted as having sessile buds; Tasmanian forms are never sessile, whereas specimens of *E. rubida* collected by me in Victoria have umbels with completely sessile buds. Other important differences will be noted.

1. **E. ovata** Labill. (*E. acervula* Hook., f.). Labill., 1806—Nov. Holl. Pl. ii, 153. A medium to small tree, but sometimes up to 30 m. Bark usually rough at the base, but smooth deciduous on portion of trunk and upper limbs. White or brown in colour. Old isolated trees sometimes exhibit a black scaly bark persistent on whole of trunk. Juvenile leaves opposite for 4 or more pairs, ovate to orbicular, undulate, very shortly petiolate, 4-8 × 3-7 cms., glaucous

to green. Intermediate leaves alternate, ovate to ovate-lanceolate, with long petioles 11 × 5 cm. or larger. Mature leaves alternate-ovate to ovate-lanceolate, undulate, sometimes emarginate, subvernicose with long petioles, thinly to thickly coriaceous, venation clearly defined, 9-12 × 1·3-5 cm. Umbels axillary, 4-8 flowered. Peduncles terete to compressed, 5-12 mm. Buds pedicellate, elliptical with obconical calyx-tube, 8-9 mm. × 5-7 mm. Operculum pointed, subrostrate, equal or slightly greater in altitude than the calyx-tube. Fruit obconical, 5-9 × 6-8 mm. Valves exsert.

Habitat: Common at sea-level, where it is found growing in sandy and poor soil. It also thrives in swampy ground at an elevation, and in some northern districts is called ' Swamp Gum '.

Distribution: Common at sea-level and up to 2000 feet. Also Victoria, New South Wales, and South Australia. Marked differences are observable between *E. ovata* in Victoria and Tasmania. The South Australian trees match those of the Tasmanian distribution very well.

Affinities: With *E. aggregata.*

Hybrids: Hybridizes freely with *E. viminalis* and probably *E. salicifolia.* One hybrid with *E. globulus* has been investigated (see note to Group 3). The forms with glaucous juvenile foliage occasionally found may be due to hybridization with *E. pauciflora*, with which this species is sometimes associated in Midland districts.

2. **E. aggregata** Deane and Maiden (*E. Rodwayi* Baker and Smith). Deane and Maiden, 1900—Proc. Linn. Soc. N.S.W., XXV, 104. A medium to tall tree, up to 45 m. Bark rough, dark, fibrous, persistent to the secondary branches, suggesting that of a black peppermint (*E. salicifolia*), with which this species is confused by uncritical observers. Juvenile leaves opposite for 4 to 5 pairs, ovate to oblong, with reduced petioles 4-6 × 1·5-3·5 cm. Intermediate leaves ovate to narrow-lanceolate. Mature leaves alternate, petiolate, narrow-lanceolate to narrow-falcate-lanceolate, venation obscure when fresh, dark-green and shining, 7-12 × 1·5-2·3 cm. Umbels 4-8 flowered. Peduncles slender, 4-6 mm. Buds elliptical, shortly pedicellate, 3-4 × 4-5 mm. Operculum conical, equal to or slightly exceeding the calyx-tube. Fruit hemispherical, shortly pedicellate, 4 × 5 mm. Valves exsert.

Habitat: Prefers marshy land at an elevation.

Distribution: Tasmania—Victoria Valley, Interlaken, Penstock Lagoon, Guildford Junction. Also New South Wales.

Affinities: With *E. ovata.*

Hybrids: The black fibrous bark of the tree is a constant character, and the infrequent smooth barks are found in a mixed stand of *E. pauciflora* and *E. aggregata.* Occasional seedlings of these trees have a tendency to glaucousness, suggesting hybridization with *E. pauciflora.*

3. **E. globulus** Labill. Labillardière, 1799—Relation du Voyage Recherche Perouse, 1, 153. A small to large tree, depending mainly on type of soil conditions, 6-45 m. Bark smooth, deciduous, sometimes rough and deeply furrowed on the whole or half the trunk, olive-green to reddish-brown. Juvenile leaves opposite for an indefinite number of pairs, sessile to amplexicaul, glaucous, oblong-ovate to oblong-lanceolate, 7-16 × 4-9 cm. The non-glaucous juvenile leaves occasionally found on Mt. Wellington, and perhaps elsewhere, are probably due to hybridization with *E. viminalis* or even *E. ovata*. Intermediate leaves petiolate, alternate broad-lanceolate to ovate-lanceolate and falcate-lanceolate. Mature leaves alternate, petiolate, dark-green, subvernicose to vernicose, lanceolate to falcate-lanceolate, 10-30 × 3-4 cm. or larger. Umbels axillary, usually 1-flowered, sessile. Terminal umbels are occasionally 3-flowered, and rare trees have a majority of 3-flowered umbels. A polymorphic hybrid swarm connects *E. globulus* with *E. viminalis*, and it is possible that these 3-fruited forms are components. A specimen showing *E. globulus* budding in the opposite-leaved stage, collected by Mr. E. Cruickshank from the stump of a felled tree at Glenorchy, is preserved in the Rodway Herbarium. Peduncles much reduced, compressed, broad or triangular. Buds glaucous, turbinate, rugose, quadrangular, 20-30 × 20 mm. Operculum calyptriform, umbonate, rugose, shorter than the calyx-tube. Fruit sessile, depressed globular to turbinate, rugose, quadricostate, 10-20 × 15-30 mm. Disc large, convex, thick, smooth, sometimes covering valves which are slightly exsert.

Habitat: Prefers moist, well-drained, sandy soil in sheltered valleys, and in these conditions grows to a tall timber tree. When growing on dry mudstone hills it is reduced almost to shrub-like dimensions, and acquires a mallee habit. Will flourish in sandy soil at sea-level.

Distribution: Blakely (1934) does not give any mainland localities for *E. globulus*. I am informed by Mr. St. John, of the National Herbarium, Melbourne, that *E. globulus* with single fruits in the umbel grows in Victoria. I have not seen these trees in the field. Both from field observation and evidence from seed-raising I am fully convinced that *E. St. Johnii* R. T. Baker and *E. bicostata* Maiden Blakely and Simmonds, included as varieties of *E. globulus* in Flora of Victoria (Ewart, 1930), although allied to *E. globulus*, are specifically distinct from it.

Tasmania: Common on East and South-East Coast, Risdon, Mt. Wellington, Spring Hill.

Affinities: With *E. Johnstoni.*

Hybrids: With *E. viminalis*, *E. ovata*, *E. urnigera.*

4. **E. cordata** Labill. Labillardière, 1806—Nov. Holl., Pl. ii, 13, t. 152. A small shrub to tall tree, 1·2-60 m. In this connection the following quotation from the Crit. Rev. (Maiden), Pt. 51, Vol. VI, is important: 'Mr. L. Rodway, of Hobart, writes to me that at Cape Frederick Henry, Brown Mt., and Ridgeway it is a scrambling

to semi-erect shrub of about 4 or 5 feet. In the South-West Gully at Chimney Pot Hill, close to Ridgeway, it is a small tree up to, say, 20 feet in height. At Uxbridge he has seen trees of it approximately 100 feet, and Mr. Fenton, of that town, an experienced timber-cutter, brought him a specimen in typical foliage and flower from a tree that was 200 feet high, with a clean branchless bole for 100 feet, and with timber light yellow ochre in colour'. I have seen the Uxbridge specimens in the Rodway Herbarium, and they are without a doubt close to the type. Further observations and research are necessary with this species. Bark smooth, white, with green to purplish blotches. Juvenile leaves opposite for an indefinite number of pairs, cordate to cordate or even oblong-lanceolate, crenulate, sessile, amplexicaul, glaucous. Intermediate foliage similar to the juvenile. Mature leaves opposite, sessile to amplexicaul, cordate to ovate-lanceolate. Umbels axillary, 3-flowered. Peduncles 5-10 mm. Buds sessile, turbinate to depressed-urceolate. Operculum calyptriform, umbonate to subapiculate, shorter than the calyx-tube. Fruit sessile, glaucous, ovate-truncate to globular. Valves 3-4, deeply enclosed.

Habitat: More information is necessary (see note above on size of tree). I am not as yet able to say that the small scrambling shrubs at Brown Mt. will give seedlings that grow to tree dimensions under favourable conditions. A medium tree growing in a Hobart garden is said to be raised from seed collected at Chimney Pot Hill, Mt. Wellington.

Distribution: Confined to Tasmania. Mt. Wellington, Brown Mt., Port Arthur, Nelson's Tier, Recherche Bay.

Affinities: With *E. urnigera.*

Hybrids: With *E. globulus.*

5. **E. viminalis** Labill. Labillardière, 1806—Nov. Holl., Pl. ii, 12, t. 151. A small to medium tree, 6-15 m. Bark smooth, white, deciduous, or scaly rough at base, occasional trees with a more or less deeply furrowed bark to upper branches. Juvenile leaves opposite for an indefinite number of pairs, dark to light green, glossy in the comparatively pure types, sessile to amplexicaul, 5-10 × 1-3 cm. or larger. Intermediate leaves petiolate, alternate, broadly-lanceolate to falcate. Mature leaves alternate, lanceolate, lanceolate to falcate-lanceolate, 11-18 × 1·5-2 cm. Umbels axillary, 3-flowered. Peduncles terete, 3-6 mm. Buds with short to well-developed pedicels, ovoid to cylindroid, 5-7 × 4-5 mm. Operculum obtuse to acute, hemispherical to conical, as long as or shortly longer than the calyx-tube. Fruit pedicellate, spherical to turbinate, 5-6 × 7-8 mm. Disc prominent, subconvex to convex. Valves 3-4, strongly exsert.

Habitat: Will thrive in sandy or clay soils, but prefers well-drained moist conditions in sheltered valleys.

Distribution: Tasmania. Common except in south and west.

Affinities: With *E. rubida* and *E. Dalrympleana.*

Hybrids: With *E. rubida, E. ovata, E. globulus,* and *E. salicifolia.*

A polymorphic hybrid swarm connects *E. globulus* and *E. viminalis.* Some of these components with normal *viminalis* fruits produce juvenile foliage of normal dimensions, but strongly to faintly glaucous, others have sub-glaucous, broad ovate-lanceolate leaves (see Plate XV, fig. 3). Some of these which are comparatively common on Mt. Wellington have been confused with *E. Dalrympleana.* A specimen in the Rodway Herbarium from Mt. Nelson, labelled *E. Dalrympleana* by Maiden, matches the foliage shown in Plate XV, fig. 3. Such specimens as these probably explain the mention of Chimney Pot Hill by Blakely in 'Key to Eucalypts' as a locality for *E. Dalrympleana.*

Also the existence of occasional rough barked trees of *E. viminalis,* to be seen at Lindisfarne and elsewhere, probably explains the reference to *E. Huberiana* Naudin for Tasmania in the same volume. I am well acquainted with *E. Huberiana* in South Australia and Victoria, and believe it to be similar to those species in Group 2, i.e., it consists of many hybrid races in various stages of stability. Seedlings raised from these different forms exhibit marked differences almost from the cotyledon stage. Examination of *E. viminalis* in the Lofty Range, South Australia, and in Victoria and Tasmania, suggests that the biotype is smooth-barked and 3-fruited. The many-fruited, smooth-barked forms do not produce more or less pure stands as do the rough-barked races at present called *E. Huberiana.* Occasional smooth-barked, many-fruited forms are found in Tasmania. The origin of these is most probably hybridization with *E. ovata*; the many-fruited character is not present in every umbel. A large proportion of the umbels carry the typical cruciform arrangement of three buds. Smooth-barked hybrids with *E. salicifolia* (quite distinct from *E. linearis* and the occasional deciduous or semideciduous forms found in a pure stand of *E. salicifolia*) are often present where these two species meet, as at Westerway.

6. **E. rubida** Deane and Maiden. Deane and Maiden, 1899—Proc. Linn. Soc. N.S.W., xxi, 156. A very glaucous small to tall tree, 9-30 m. Bark smooth, white, often blotched pink or red. Juvenile leaves opposite for an indefinite number of pairs, glaucous, sessile, cordate to orbicular or ovate, 2-6 × 2·5-5 cm. Intermediate leaves petiolate, glaucous, ovate to ovate-lanceolate, short-lanceolate to falcate-lanceolate. Mature leaves alternate, petiolate, lanceolate to falcate-lanceolate subvernicose, 10-18 × 2-3·5 cm. Branchlets bear a fine glaucous bloom. Umbels axillary, 3-flowered. Peduncles subterete, 3-6 mm. Buds glaucous or subglaucous, ovoid, 6-7 × 4-5

mm., shortly to distinctly pedicellate. Operculum conical to hemispherical, equal to calyx-tube. Fruit pedicellate, subglaucous to glaucous, 4-6 × 4-8 mm., hemispherical to turbinate. Disc flat to domed. Valves exsert.

Habitat: Prefers open country at an altitude of 1000 to 2000 feet. Thrives on poor soils of mudstone varieties.

Distribution: Tasmania. Westerway, Ouse, Conara, St. Marys. Also South Australia, Victoria, New South Wales, Queensland.

Affinities: With *E. viminalis* and *E. Dalrympleana.*

Hybrids: With *E. Dalrympleana* where the two species meet. A wide variability in size of fruit can be seen from measurements above. Seedlings raised from a tree of the small-fruited type exhibit a wide range of variability in juvenile leaves, both in colour and shape. Some have practically normal shape, but are dark glossy green. It is not yet possible to say whether the small fruit is associated with the hybrid character.

An observer of *E. rubida* in South Australia, Victoria, and Tasmania might incline to the view that the most 'typical' *E. rubida* is in Tasmania. In the first mentioned State a high degree of hybridization has taken place. It is safe to assume that the multi-flowered *E. rubida* is of hybrid origin. I have in my possession seedlings from such a tree growing at Woodside, South Australia. Almost perfect segregation towards *E. camaldulensis* Dehn. (*E. rostrata* Schlecht.) and *E. rubida* is shown.

7. **E. urnigera** Hook., f. Hooker, f., 1847—Lond. Journ. Bot., Part VI, 477. A small to medium tree, with drooping branches, 9-12 m. Bark smooth, deciduous, white, blotched green and red. Juvenile leaves opposite for an indefinite number of pairs, strongly glaucous in type, cordate, orbicular to elliptical or ovate, sessile to shortly petiolate, crenulate, 6 × 7 cm. or larger. These leaves bear a striking resemblance to the mature leaves of *E. cordata.* Mature leaves alternate, petiolate, green, narrow to broad-lanceolate, 8-18 × 1·7-2·5 cm. Umbels axillary, 3-flowered. Peduncles compressed to subterete, 13-20 mm. Buds urceolate, petiolate, glaucous, 12-14 × 7 mm. Non-glaucous buds and fruit departing from these rough limits of measurement are most probably hybrids of *E. Johnstoni,* or represent a comparatively stabilized race with glossy, dark-green, juvenile foliage, probably derived by hybridization from *E. Johnstoni,* and confined to Mt. Wellington. (See note under *E. Johnstoni.*) Operculum umbonate or subapiculate, forming a cap to the calyx-tube, and much shorter than it. Fruit pedicellate, urceolate, 15-17 × 7-10 mm. Valves deeply enclosed.

Habitat: Prefers well-drained situations at sub-alpine levels.

Distribution: Confined to Tasmania. Mt. Wellington and common on the Central Plateau.

Affinities: With *E. divaricata.*

Hybrids: With *E. Johnstoni,* also probably *E. Dalrympleana,* and *E. subcrenulata.*

The following extract from the Crit. Rev. (Maiden) refers to the variety *E. elongata* of Rodway: ‘ A tall, spreading tree. Bark smooth, white. Leaves linear-lanceolate, 4-8 inches long. Peduncles not very long. Operculum conical umbonate, half as long as the capsule. Fruit pyriform-globose, slightly constricted, ⅓-inch long. Capsule much sunk. (‘ The Tas. Flora ’, p. 58.)

Mr. Rodway (in a letter to me) points out the close resemblance of the juvenile foliage of this form to that of *E. viminalis.* He has suggested the possibility of this form being a hybrid between *E. urnigera* and *E. viminalis,* and says that wherever he has seen the variety growing, he has always seen the two species associated ’.

Insufficient note has been taken in the past of Rodway’s field observations of this type. In my experience his opinions on natural hybrids of *Eucalyptus* have always been most reliable.

8. **E. subcrenulata** Maiden and Blakely. Maiden, 1929—Crit. Rev., Part LXXI, 59. A small alpine tree to large timber tree, up to 60 m., with a smooth deciduous bark of brilliant orange when freshly exposed. Juvenile leaves opposite for an indefinite number of pairs, dark glossy green, sessile, orbicular to ovate, subcrenulate and undulate. Intermediate leaves alternate, petiolate, broadly ovate to oblong-lanceolate, subcrenulate, dark-green, vernicose, 5-10 × 3-5 cm. Mature leaves alternate, with long subterete petioles, oblong to oblong-lanceolate and narrow falcate-lanceolate, coriaceous, subcrenulate, 5-12 × 1·5-2·5 cm., dark-green and vernicose. All leaves change colour to light-green on drying. Umbels axillary, 3-flowered. Peduncles 2-4 mm. or longer. Buds sessile, ovoid to globular, compressed at the base, 6-8 × 5-6 mm., irregularly ribbed or faintly winged to smooth, pitted rugose; operculum conical, obtuse to subrostrate, usually shorter than the calyx-tube. Fruit hemispherical to shortly campanulate. Valves strongly exsert.

The type description as published by Blakely (1934) is misleading, as it was probably described on insufficient material. It is there regarded as a small alpine tree. This tree, which is very common on the Central Plateau, was previously thought to be *E. Johnstoni.* On a collecting trip to National Park, Prof. A. L. McAulay concluded that this form of *E. Johnstoni,* as then regarded, is identical with *E. subcrenulata,* and later, on Biological Survey work in the same district, considered that the reduced alpine forms are identical with the tall timber tree below Lake Fenton, also previously regarded as *E. Johnstoni.* In these opinions I concur, and have shown from a rough statistical examination that the group of forms under the name of *E. Johnstoni* at present confined to Mt. Wellington is distinct from *E. subcrenulata.* The reduced alpine forms of this species are undoubtedly the forms showing transit to *E. vernicosa* described by Rodway and others.

Habitat: Alpine and sub-alpine situations. In sheltered situations the tree thrives and grows to large dimensions.

Distribution: Confined to Tasmania. Common on the Central Plateau, extending north to Cradle Mt.

Affinities: With *E. vernicosa* and *E. Johnstoni.*

Hybrids: With *E. Gunnii.*

9. **E. vernicosa** Hook., f. Hooker, f., 1847—Lond. Journ. Bot., VI., 478. A shrub or small tree, often of twisted appearance, 1·2-3·6 m. Bark smooth, deciduous, brown-orange. Juvenile leaves dark-green, glossy, opposite for an indefinite number of pairs, sessile or shortly petiolate, elliptical to oblong or oblong-lanceolate, 1·5-2 × 1-2 cm. Intermediate leaves similar to juvenile, but with developed petioles. Mature leaves opposite or alternate, elliptical to lanceolate, petiolate, subcrenulate, dark-green, strongly vernicose and thick, 1·5-5 × 1·5-2 cm Umbels axillary, 1-3 flowered. Peduncles thick, 1·5-5 mm. Buds sessile, elliptical, 7-8 × 5 mm. Operculum hemispherical, apiculate or sharply conical, equal to or shorter than the slightly ribbed calyx-tube. Fruit sessile, hemispherical to shortly campanulate or subcylindrical, 5-7 × 7-8 mm. Valves 3-5, enclosed.

Habitat: Alpine situations.

Distribution: Confined to Tasmania. Mt. Fatigue, Mt. La Perouse to Arrowsmith, West Coast, Mt. Sorell, Macquarie Harbour, Cradle Mt.

Affinities: With *E. subcrenulata* and *E. Johnstoni.*

Hybrids: Trees growing on the shores of Sutton's Tarn in the Cradle Mt. Reserve strongly suggest hybridization with *E. subcrenulata.* A study of material collected over a wide area appears to indicate two biotypes: a single-fruited form, common in the south-west, and a 3-fruited form. The Cradle Mt. trees are exclusively of the latter. It is tentatively suggested that this latter may have arisen from hybridization with *E. subcrenulata.* Further field and horticultural observation is necessary on this point.

10. **E. Archeri** Maiden and Blakely. Maiden, 1929—Crit. Rev., Part LXXI, 58. A small shrub or dwarf stunted to medium tree, 3-9 m. Bark smooth, deciduous, orange in colour, sometimes scaly at base. Juvenile leaves glaucous, opposite for an indefinite number of pairs, sessile to shortly petiolate, cordate to orbicular or elliptical. Intermediate leaves elliptical to oblong-lanceolate or spathulate. Mature leaves alternate, coriaceous, narrow-lanceolate to broad-lanceolate and falcate-lanceolate, 5-10 × 1-3 cm. Umbels axillary, 3-flowered. Peduncles compressed, 3-7 mm. Buds sessile or nearly so, oblong or cylindrical, 5 × 6 mm. Operculum hemispherical, obtuse, 2-3 times shorter than the calyx-tube. Fruit, sessile, ovoid-truncate to campanulate, 6-7 × 5-6 mm. Valves deeply sunk, with tips minutely emerging at times.

Habitat: An alpine to sub-alpine species.

Distribution: Confined to Tasmania. Western Tiers and Mt. Barrow. The type specimen which, through the kindness of Mr. Blakely, I have been able to see is given as from the Western Mts. Doubtless this means the Western Tiers. Material collected from this locality matches the type very well.

Affinities: With *E. Gunnii* and *E. divaricata.*

Hybrids: There is a specimen in the Rodway Herbarium, labelled *E. Gunnii*, from the Western Tiers. A pencil note of the collector calls attention to the strong resemblance of the buds to those of *E. viminalis.* These would certainly pass for buds of *E. viminalis*, if separated from the fruit. The pedicels are up to 2 mm. in length, while fruit and leaves are close to the type of *E. Archeri.* The specimen certainly suggests a hybrid of possibly *E. Dalrympleana.*

11. **E. divaricata** McAulay and Brett, sp. nov. (Plate XVII.) Arbor divaricata, alta 12-15 m.; cortice squameo; ramulis tenus persistente, cinereo, v. nigro. Folia juvenilia bina opposita per multa paria, cordato-orbiculata v. elliptica, sessilia vel. brevi-petiolata, 2·5 cm. longa, 2 cm. lata. Folia intermedia alterna, petiolata, elliptica v. oblongo-lanceolata. Folia matura glauca v. atroviridia, alterna, angusto v. lato-lanceolata, v. falcato-lanceolata, 4-8 cm. longa, 1·5-3 cms. lata. Umbellae axillares, 3-florae, pedunculis compressis v. sub-compressis, 5-10 mm. longis. Gemmae sessiles v. brevi-pedicellatae, glaucae, obovatae v. cylindriformes, 6-8 cm. longa, 5 mm. lata. Operculum plano-hemisphaericum v. planum v. calyptriformem, subapiculatum, brevius quam calycis tubo. Capsulae, glaucae, cylindriformes v. suburceolatae, 7-9 mm. longae, 6 mm. latae. Valvae inclusae.

A small to medium umbrageous tree, with markedly divaricating branches, 12-15 m. Bark rough, scaly, grey to black, persistent on the trunk and branches; the branchlets covered with a light to heavy glaucous bloom. Juvenile leaves opposite for an indefinite number of pairs, glaucous, cordate orbicular to elliptical, sub-crenulate, sessile to shortly petiolate, 2·5 × 2 cm. In a general way the juvenile leaves of *E. Gunnii* are larger than those of *E. divaricata* and *E. Archeri*, whilst the glaucousness of the juvenile *E. divaricata* is more marked than that of either of the other two. Intermediate leaves alternate, petiolate, elliptical to oblong-lanceolate or lanceolate. Mature leaves green, alternate, petiolate, narrow to broad-lanceolate or falcate-lanceolate, 4-8 × 1·5-3 cm. Umbels axillary, 3-flowered. Peduncles compressed to almost terete, 5-10 mm. Buds sessile to shortly pedicellate, glaucous, obovate to cylindroid, 6-8 × 5 mm. Operculum depressed, hemispherical or flat to cap-shaped, sub-apiculate, shorter than the calyx-tube. Fruit glaucous, cylindroid to sub-urceolate, often urceolate when immature, 7-9 × 6 mm. Disc small, slightly convex, valves deeply sunk.

Habitat: A sub-alpine species; prefers open flats at an altitude of about 3000 feet.

Distribution: Northern and eastern shores of the Great Lake, Miena, skirting St. Patrick's Plains, Arthur Lakes. Confined to Tasmania.

Affinities: With *E. Gunnii*, *E. Archeri*, and *E. urnigera.*

Hybrids: With *E. Dalrympleana.* There are many hybrids of these two species on Alma Tier. The trees resemble *E. Gunnii* in their smooth barks and pedicellate buds. The juvenile foliage of the seedlings is very distinct from that of juvenile *E. divaricata.* It is much larger and less glaucous.

12. **E. Gunnii** Hook., f. Hooker, J. D., 1844—Lond. Journ. Bot., iii, 499. A medium to tall tree, up to 30 m. Bark smooth, deciduous, scaly, persistent at base of old trees, orange to pinkish-white. Juvenile leaves opposite for an indefinite number of pairs, glaucous, cordate, orbicular to elliptical, sessile to shortly petiolate, 3-4 × 2-4 cm. or larger. Intermediate leaves alternate, elliptical to oblong-lanceolate, green to glaucous, crenulate. Mature leaves alternate, narrow to broad-lanceolate, 4-7 × 1·5-3 cm. Umbels axillary, 3-flowered. Peduncles compressed to terete, 3-8 mm. long. Buds sub-glaucous to non-glaucous, pedicellate, cylindroid, with an umbonate or mucronate operculum less than the calyx-tube. Fruit shortly pedicellate to nearly sessile, hemispherical or campanulate to ovoid-truncate, 7-10 × 5-8 mm. Valves sunk in capsule, not exsert.

Habitat: A sub-alpine tree, preferring marshy conditions.

Distribution: This tree has been reported both in Victoria and New South Wales. I have not seen the specimens from the summit of Mt. Baw Baw, Victoria, but have raised plants from seed labelled *E. Gunnii* collected in New South Wales. The seedlings bear no resemblance to those of *E. Gunnii.* I believe, with R. T. Baker (1912), that this species is confined to Tasmania.

Tasmania: The Middlesex Plain, Alma Tier, Mt. Arrowsmith.

Affinities: With *E. Archeri* and *E. divaricata.*

Hybrids: With *E. Dalrympleana* (Baker's Tier) and *E. subcrenulata* (Cradle Mt. Reserve).

The following two specimens in the Rodway Herbarium strongly suggest natural hybridization with *E. subcrenulata.* Both were collected on Mt. Field (whether East or West is not stated). In this area the two species form an association.

Specimen I, labelled *E. Gunnii* H. Mt. Field, 1902: The buds are large, and resemble those of *E. Gunnii*, but peduncles are long, equal to or exceeding 8 mm. The fruit is that of *E. subcrenulata.* The sucker foliage would match that of *E. urnigera.*

Specimen II, labelled *E. Gunnii*, cultivated in Hobart from seed collected on Mt. Field: Only buds appear, and all parts are more highly glaucous, but there are strong resemblances, particularly in long peduncles, to Specimen I.

13. **E. Perriniana** (F. v. M.) Rodway Rodway, 1893—Pap. Roy. Soc. Tas., 181. A small, shrub-like tree of mallee habit to medium tree, about 3-12 m. Bark smooth, deciduous, of glaucous appearance, with pruinose blotches, sometimes scaly at base. The mature tree presents a glaucous pruinose appearance. Juvenile leaves opposite for an indefinite number of pairs, glaucous, perfoliate, orbicular to elliptical-cordate, 5-6 × 4-10 cm. Intermediate leaves glaucous, ovate, connate at base or opposite and sessile, or alternate, lanceolate or falcate-lanceolate, petiolate. Mature leaves glaucous, petiolate, alternate, lanceolate to falcate-lanceolate, up to 13 × 1-2·5 cm. Old trees may exhibit all three types of foliage on the one secondary branch. Umbels axillary, 3-flowered. Peduncles 2-5 mm. Buds glaucous, sessile, with central pedicel sometimes developed, 6-9 × 4-7 mm. Fruit glaucous, sessile, truncate-globose to subcylindrical, 5 × 7-8 mm. Valves 4-5, completely enclosed or minutely exsert.

Habitat: Prefers poor soil of the mudstone variety at an elevation.

Distribution: Tasmania (Tunnack, Strickland); also Victoria and New South Wales.

Affinities: Possibly with *E. Gunnii.*

Hybrids: None observed.

14. **E. obliqua** L'Herit. L'Heritier, 1788—Sert. Angl., p. 18, t. 20. A medium to tall tree, 15-60 m. Bark fibrous, deeply furrowed, and persistent to branchlets, occasionally smooth, deciduous on branches. Juvenile leaves opposite for 3-4 pairs, petiolate, lanceolate to elliptical-lanceolate, 6-8 × 3-4 cm. Intermediate leaves alternate, obliquely ovate to lanceolate, bright green or yellowish-green and shining, up to 20 × 14 cm. or larger. Mature leaves alternate, petiolate, oblique-lanceolate, 10-16 × 2-3 cm., thick and shining. Umbels axillary, 7-16 flowered. Peduncles compressed to subterete, 8-13 mm. Buds clavate, pedicellate, 7 × 3-5 mm. Operculum hemispherical, smooth or apiculate, shorter than the calyx-tube. Fruit pyriform, truncate, pedicellate, 8-12 × 8-10. Disc oblique. Valves deeply enclosed.

Habitat: Grows from sea-level to a moderate altitude. Thrives best in well-drained sandstone soils in sheltered valleys.

Distribution: Common in Tasmania. Also South Australia, Victoria, and New South Wales.

Affinities: With *E. regnans* and *E. Sieberiana.*

Hybrids: With *E. regnans* on Mt. Wellington; ×*E. Risdelata* on Tasman's Peninsula; also possibly with ×*E. Risdosalicilata* on Mt. Wellington, as smooth-barked types can be found with fruit-bearing, broad, flat discs, quite unlike the pyriform, obliquely rimmed fruit of *E. obliqua.*

15. **E. gigantea** Hook., f. Hooker, J. D., 1847—Lond. Journ. Bot., VI, 479; also 1860—Flora Tas., i, 136 (*partim*). A tall tree, 18-30 m. The smaller trees are possibly of hybrid origin. Bark rough, fibrous, deeply furrowed, persistent, grey in colour, extending for variable distances up the trunk; occasional trees bear strips of smooth bark to the base or are almost entirely smooth-barked (see note under hybrids). The smooth deciduous portions cream in colour, streaked with grey. The foliage tree presents a sub-glaucous appearance which is very characteristic. The sapling is markedly glaucous both on leaves and trunk. Occasional trees, as on Alma Tier, develop a marked weeping habit, with long pendulous branches of striking appearance. Juvenile leaves opposite for 3-4 pairs, petiolate, glaucous, lanceolate. Intermediate leaves alternate, oblong-elliptical to oblique-lanceolate, glaucous. Mature leaves alternate, petiolate, sub-glaucous, narrow-lanceolate to broadly oblique-lanceolate, 8-16 × 2-5 cm.; the branchlets covered with fine to heavy glaucous foliage. Umbels axillary, 7-15 flowered. Peduncles flattened to terete, 10-20 mm. or even longer. Buds clavate, pedicellate, faintly glaucous, 7-8 × 4-7 mm. Operculum hemispherical, obtuse or minutely umbonate, shorter than the calyx-tube. Fruit pedicellate, pyriform to globose-pyriform or falcate-pyriform, 10-14 × 9-13 mm. Disc thin, oblique to suboblique; valves enclosed.

Habitat: Prefers an altitude of 2000-3000 feet.

Distribution: Common in Tasmania, forming forests at an altitude from 2000-3000 feet. Also Victoria and New South Wales.

Affinities: With *E. obliqua* and *E. Sieberiana.*

Hybrids: With *E. obliqua.* On Mt. Wellington, small to medium trees, with practically smooth bark, shining mature leaves, and smaller fruits than the forest tree, suggest hybridization with *E. regnans* at the levels where the two trees are closely associated. In districts where the species associates with *E. Dalrympleana*, trees bearing smooth bark almost to the base are frequently found. The rough portions of the bark are scaly rather than fibrous, and the timber, according to Mr. L. Connell, of 'Waldheim', Cradle Mt., is of very inferior quality to that of the typical gum-top stringybark. The fruit is globose to sub-pyriform, with a broad convex rim, reminiscent of *E. Dalrympleana.*

16. **E. regnans** F. v. M. F. von Mueller, 1870—Rept. Accl. Soc. Vict., 20. A medium to very tall tree, 12-90 m. or taller. Some very tall trees of this species beyond the above limits have been reported in Southern Tasmania, but in the absence of absolutely reliable estimates no measurements are quoted. Bark smooth, deciduous on trunk and limbs, often peeling in long ribbons, occasionally persistent. The colour when freshly exposed is bluish-grey, occasionally streaked with cream. Juvenile leaves opposite for 2-3 pairs, shortly petiolate, lanceolate. Intermediate leaves petiolate, broad-lanceolate

to oblique-lanceolate, alternate. Mature leaves subvernicose, alternate, petiolate, narrow to broad oblique-lanceolate, acuminate, 10-16 × 2-5 cm. Venation with a semilongitudinal tendency. Umbels axillary, sometimes in pairs, 7-15 flowered. Peduncles terete, 8-15 mm. Buds clavate, pedicellate, 7-9 × 5 mm. Operculum hemispherical to conoid, shorter than the calyx-tube. Fruit pedicellate, obconical to campanulate, 7-8 × 5-6 mm. Disc flat to sub-oblique. Valves enclosed.

Habitat: Prefers moist, well-drained soil near running water. Forms stands at sea-level, but prefers rain forest conditions, and attains large dimensions in mountain gullies.

Distribution: Common up to an altitude of about 2000 feet. Also Victoria.

Affinities: With *E. obliqua*. Regarded by Mueller as having an affinity with *E. salicifolia*, but almost every character for comparison in Eucalypts separates the two trees.

Hybrids: With *E. obliqua*, and possibly *E. gigantea*.

17. **E. Sieberina** F. v. M. F. von Mueller, 1879—Eucalyptographia, Dec., ii. A medium to tall tree, 15-30 m. Bark rough, deeply furrowed, dark-grey, persistent on trunk; upper branches with smooth deciduous bark, cream in colour when freshly exposed. The branchlets and stem of saplings markedly glaucous. Juvenile leaves opposite for 4 to 5 pairs, sessile to shortly petiolate, elliptical to broadly lanceolate, glaucous, coriaceous, 8-12 × 5-7 cm. Intermediate leaves alternate, petiolate, glaucous, broadly lanceolate to sub-oblique-falcate-lanceolate. Mature leaves alternate, petiolate, lanceolate to falcate-lanceolate, vernicose, with semilongitudinal venation, 9-18 × 1·5-2 cm. Umbels axillary, 5-12 flowered. Peduncles strap-shaped, 7-14 mm. or longer. Buds clavate, pedicellate, 5-7 × 3-5 mm. Operculum hemispherical, shorter than the calyx-tube. Fruit pedicellate, pyriform-truncate, 8-11 × 7-8 mm.; disc small, flat or oblique; valves enclosed.

Habitat: Prefers coastal belts of sandy soil or valleys at a moderate altitude.

Distribution: Tasmania—Occupies a coast belt on the North-East Coast, Falmouth, George's Bay, St. Mary's Pass, &c. Also Victoria and New South Wales.

Affinities: With *E. gigantea* and to some extent *E. obliqua*.

Hybrids: With *E. salicifolia*. A polymorphic hybrid swarm connects *E. salicifolia* and *E. Sieberiana* where the two species are mixed. Also with *E. obliqua*. The *obliqua* hybrids have markedly oblique-lanceolate leaves.

18. **E. salicifolia** (Sol.) Cav. (*E. amygdalina* Labill.) Cav., 1797—Ic., iv, 24. A shrub to medium tree, depending on soil conditions and situation, 3-15 m. Bark fibrous, grey, persistent on the trunk

and branches. Often deciduous on the branches, and an occasional tree in a stand will present smooth bark to the butt. (Such a tree is quite distinct from *E. linearis.*) Juvenile leaves opposite for an indefinite number of pairs, linear to narrow-lanceolate, pale-green or glaucous, 0·7-1·5 cm. Intermediate leaves alternate, petiolate, lanceolate to falcate-lanceolate. Mature leaves petiolate, alternate, narrow-lanceolate to linear-lanceolate and linear-falcate, 4-10 × 0·7-1 cm. Umbels axillary, 5-12 flowered. Peduncles terete, 5-10 mm. Buds clavate, pedicellate, 4 × 3 mm. Operculum hemispherical, obtuse, shorter than the calyx-tube. Fruits pedicellate, hemispherical to sub-globose, 5 × 7 mm. Disc flat or sub-convex. Valves enclosed or slightly exsert.

Habitat: Prefers open country and sandstone soils. Extends from sea-level to an altitude of 3000 feet or even higher.

Distribution: Widely distributed throughout Tasmania, and is confined to the State.

Hybrids: E. salicifolia, particularly at sea-level, is a very distinct biotype, and forms pure stands, often of considerable extent. Many hybrid races of varying degrees of fixation make this species at times somewhat bewildering. The principal hybridization has probably occurred with *E. viminalis* (see note on hybrids of *E. viminalis*), *E. ovata* and × *E. Risdelata.* It is possible to note the influence of the last mentioned in the sucker foliage that follows destruction of a small stand by fire. Numerous instances of this occur in Southern Tasmania, e.g., about one mile from Huonville on the Hobart side. Tall, smooth-barked trees can be found with broad leaves where this species associates wih *E. viminalis* and *E. ovata.* A notable example of this occurs on Tunnel Hill, Cambridge.

Affinities: With *E. linearis.*

19. **E. tenuiramis** Miq. Miquel, 1856—Ned. Kruidk. Arch., iv, 128. An imperfectly investigated species for Tasmanian distribution. Isolated trees at Risdon in *E. Risdoni; E. salicifolia* associations possess characters intermediate between the two species. Specimens of these were collected by Prof. A. L. McAulay, who showed that they matched the description in 'Key to the Eucalypts' (Blakely), p. 414. It was thought that they might be hybrids of the above-mentioned species. This suggestion has been justified, since seedlings show perfect segregation, and approach very closely to both the supposed parents. The specimens noted from Recherche Bay and Grass Tree Hill (*loc. cit.*) are probably of the same character. Material collected recently near Moina, from a group of trees with what appeared to be normal variation, matches very well material sent from Flinders Island. The venation, width of leaves, and other characters suggest *E. tenuiramis,* but until seedlings are raised it is not possible to label this material with any certainty.

The position appears to be roughly as follows:

(1) There are trees on Flinders Island, and possibly other Straits Islands, which may justify separation from *E. salicifolia* as a species *E. tenuiramis.*

(2) Most of, it not all, the material collected on the mainland of Tasmania, and labelled *E. tenuiramis,* is of hybrid origin, probably from *E. Risdoni.*

It remains, then, to investigate more fully the Straits Islands peppermint, and determine whether it forms any pure stands on the mainland of Tasmania.

The following description is quoted from 'Key to the Eucalypts':

> 'A small to fairly tall tree, with a little rough persistent bark on the branches. Mature leaves alternate, petiolate, oblong-lanceolate to falcate-lanceolate, shortly apiculate or acuminate, thinly coriaceous and somewhat glossy on both sides, 5-11 × 1-2·5 cm., the venation sub-obscure, the lateral veins irregular, and sometimes one or two near the base semilongitudinal, thin, diverging at an angle of 10-25 deg. to the somewhat prominent midrib; intra-marginal vein remote from the thin margin. Umbels axillary, 5-20 flowered; peduncles almost terete, 5-8 mm. long. Buds pedicellate, clavate, shining, sub-angular at the base, 5 × 4 mm. Operculum patelliform, thick, shorter than the calyx-tube. Filaments all fertile; anthers reniform, very small. Fruit sub-pyriform to ovoid-truncate, somewhat thin, 3-4 celled, 8 × 5 mm., the disc oblique or flat and scarcely exceeding the calycine ring; valves enclosed.'

Affinities: With *E. salicifolia* and *E. radiata* Sieber. The larger and different shaped fruits of the *E. tenuiramis* undoubtedly are those of the *E. Risdoni* hybrids above mentioned.

20. **E. linearis Dehn.** Dehnhardt, 1832—Cat. plant. horti. Camald., Ed. ii, 20. A small to medium tree, 6-15 m. Bark smooth, white, sometimes with bluish streaks. The narrow leaves give the tree a characteristic appearance. Juvenile leaves opposite for 5-6 pairs, minutely petiolate, linear to linear-lanceolate, 4-6 × 0·2-0·3 cm. Mature leaves alternate, petiolate, linear to linear-lanceolate or linear-falcate, 5-12 × 0·3-0·5 cm. Umbels axillary, 5-12 flowered. Peduncles terete to somewhat compressed, 7-10 mm. Buds clavate, shortly pedicellate, 4-5 × 2-4 mm. Operculum hemispherical, minutely apiculate, shorter than the calyx-tube. Fruit petiolate, broadly globose to sub-pyriform, 4-6 × 3-8 mm.; disc flat or oblique; valves enclosed.

Habitat: Shows adaptability to a variety of soils, but probably does best in those of a porous, light nature. Grows from sea-level to a moderate elevation, and thrives best in open country.

Distribution: Common in the South and East, and is closely associated with *E. viminalis* and often *E. globulus.* Some localities are: Hobart, Mt. Wellington, Kingston, Black Charlie's Opening (East Coast Road), Bagdad, Bruni Island.

Affinities: With *E. salicifolia.*

Hybrids: None observed. It is possible that the tree has had a hybrid origin from *E. salicifolia* and one of the Macrantherae, perhaps *E. viminalis,* since *E. linearis* is invariably associated with this species (see note on hybrids of *E. salicifolia*).

21. **E. Risdoni** Hook., f. Hooker, J. D., 1847—Lond. Journ. Bot., vi, 477. A very glaucous tree, 3-7·5 m. Bark smooth, deciduous, often retaining circular leaf scars until the first bark is completely shed. The bark of the adult tree is ashy-grey, streaked with cream. Juvenile leaves opposite for an indefinite number of pairs, connate, cordate-lanceolate, apiculate, glaucous, 4 × 2 cm. or larger. The connate character of the juvenile leaves is important. (Seedlings departing from this, and matching those in a hybrid swarm from a recognisable hybrid, sometimes occur in batches, raised from what is apparently a pure type.) It is suggested in this paper that the connate leaves are a constant character of the biotype, and the many departures noted in the various sessile or amplexicaul forms are due to hybridization. It is difficult to determine an intermediate leaf stage. Mature leaves opposite, connate, similar in shape to the juvenile, but becoming more lanceolate and sub-acuminate, strongly glaucous to dark glossy-green. The occasional alternate leaves observed ('Key to Eucalypts', Blakely, p. 214), it is suggested, are due to hybrid influence. Umbels axillary, 3-9 flowered. Peduncles terete to somewhat compressed, 7-10 mm. Buds clavate, strongly glaucous, pedicellate, 5-6 × 4-5 mm. Operculum hemispherical, obtuse, or apiculate, shorter than the calyx-tube. Fruit pedicellate, pyriform-truncate to nearly hemispherical, 6 × 8-10 mm. Disc moderately wide to thin and shrunken, flat to sub-oblique. Valves deeply to slightly enclosed.

Habitat: Prefers mudstone hills. The stock is non-viable and differs markedly in this respect from the forms classed under *E. Tasmanica* Blakely or the polymorphic group ×*E. Risdelata.*

Distribution: Extends from Risdon, following permo-carb. formations, to Cambridge. Muddy Plains and the valley of the South Esk are quoted by Blakely as localities, but I have not seen specimens from these districts. Confined to Tasmania.

The following quotation from Ewart, in 'Flora of Victoria', under *E. Australiana*—'In one form, sometimes known as *E. Risdoni,* the juvenile foliage is bluish-grey, with broad bases united across the stem'—must astonish any one who knows both species in the field or herbarium.

Affinities: With the polymorphic × *E. Risdelata,* which covers a great range of forms, as can be seen in Plate XVI.

Hybrids: See note on *Eucalyptus Risdoni* Hook., f.

22. **E. pauciflora** Sieb. Sieber, 1827—Spreng. Syst., ov., Cur. Post., 195. The following description is somewhat unwieldy, and probably covers two, if not three, biotypes. Further investigation is necessary with this species. A small to medium tree, 6-15 m. Bark smooth to base, white or ash-grey, streaked with white. A subalpine type, is quite fastigiate in character, and maintains this constantly; another form, often called Cabbage or Weeping gum, has remarkable pendulous branches, at times hanging in the fashion of a liana for 15 to 20 feet. Juvenile leaves opposite for 3-5 pairs, shortly petiolate, narrow to broad-lanceolate. Intermediate leaves alternate, petiolate, coriaceous, dark glossy-green to green, subglaucous to glaucous, up to 10-19 × 10-14 cm. or even larger. Mature leaves alternate, petiolate, with semilongitudinal venation, thick coriaceous, dark-green to green, shining, 8-14 × 1·5-4 cm. or larger. Umbels axillary, 5-15 flowered. Peduncles thick, terete, 7-25 mm. Buds clavate, pedicellate, 5-7 × 4-5 mm., angular or ribbed, glaucous or non-glaucous. Operculum hemispherical to sub-conical, acute, much shorter than the calyx-tube. Fruit pedicellate to shortly pedicellate, pyriform to pyriform-truncate or globose, glaucous or non-glaucous, 7-10 × 8-12 mm.; disc flat, broad to medium. Valves enclosed.

Habitat: Shows marked xerophytic characters at sea-level, where the tree flourishes in very dry conditions. The high-altitude forms often prefer moist, but not marshy, conditions.

Distribution: Common from sea-level to sub-alpine situations, and forms a very characteristic feature of eucalypt vegetation in the Midlands of Tasmania. The question of mainland distribution is an open one.

Affinities: Probably with *E. Simmondsi.* The following suggestions are made after an extensive field experience of the so-called *E. pauciflora* Sieb. in Tasmania. Three biotypes are tentatively suggested:—(1) The Weeping or Cabbage gum, so well-known in the Midlands of Tasmania. This was referred by Messrs. Baker and Smith, in 'Research on the Eucalypts of Tasmania', to *E. phlebophylla* F. v. M. There seems little doubt that this tree, although related to it, is specifically distinct from *E. pauciflora* Sieb. as described by Black in 'Flora of South Australia', Ewart in 'Flora of Victoria', and Blakely in 'Key to Eucalypts'. Mr. St. John, of the National Herbarium, Melbourne, a well-known authority on eucalypts, is of the opinion that the Tasmanian Cabbage gum is distinct from *E. pauciflora* Sieb. in Victoria. Fruit, buds, and branchlets often exhibit glaucousness. (2) A non-glaucous type, common in South-Eastern Tasmania and also at Sheffield. The sucker foliage often reaches very large dimensions; the weeping character of the branches is not as marked as in the Cabbage gum. (3) A sub-alpine type, with leaves much narrower than in (1) or (2). The tree is of fastigiate appearance, which it retains after maximum development. Forests of this type are to be observed at Interlaken and the Great Lake.

Hybrids: With ×*E. Risdelata* and *E. salicifolia.* For other important notes on hybrids see *E. Dalrympleana* and *E. aggregata.*

23. **E. coccifera** Hook., f. Hooker, J. D., 1847—Lond. Journ. Bot., vi, 477. A small to medium tree, about 1-12 m. Bark smooth, deciduous to butt, slate-grey in colour. Juvenile leaves opposite for an indefinite number of pairs, sessile, elliptical or cordate-orbicular, glaucous. Intermediate leaves alternate, petiolate, oblong-lanceolate, apiculate or sub-acuminate. Sub-glaucous. Mature leaves sub-glaucous to glaucous, alternate, petiolate, uncinate, 5-6 × 1·5-2 cm. Umbels axillary, 3-6 flowered. The 3-flowered type is characteristic of the Mt. Wellington range, and apparently does not extend north of this. Peduncles compressed and often somewhat triangular in shape, or sub-terete, 5-10 mm. Buds glaucous or sub-glaucous, clavate, angular or markedly costate, 8-10 × 5-6 mm. Operculum flat or concave, much shorter than the calyx-tube. Fruit sessile, or shortly petiolate, globose to hemispherical or broadly turbinate, shining or glaucous, smooth or somewhat furrowed or bicostate, 7-9 × 10-12 mm. Disc flat or convex, 3-4 mm. broad. Valves enclosed.

Var. parviflora Benth. Bentham, 1866—Flora Aust., iii, 204. Similar to type, but floral parts and leaves much smaller. A taller tree, up to 18 m. or taller, with much less glaucousness when growing in sheltered valleys, the mature leaves sometimes with slight sheen. Buds sometimes with a calyptra.

Habitat: An alpine species, preferring an altitude of 3000-4000 feet. The type flourishes in exposed situations, while the var. *parviflora* is found in sheltered valleys, where it attains the height of a medium tree.

Distribution: Common at alpine levels throughout the Island. The 3-fruited form, as far as can be judged, is confined to the South.

Affinities: In some of its characters it presents remarkable resemblances to some of the forms of ×*E. Risdelata.*

Hybrids: None observed.

24. **E. Dalrympleana Maiden.** Maiden, 1920—Forest Flora of N.S.W., Vol. VII, Pt. IV, 137. A medium to tall tree, 12-30 m. Bark smooth, deciduous, white or pinkish, with bluish streaks and blotches. Juvenile leaves opposite for an indefinite number of pairs, sessile, varying greatly in shape, size, and degree of glaucousness, cordate to orbicular, ovate-lanceolate to oblong-lanceolate, 4-6 × 4-5 cm., and frequently much larger. Intermediate leaves opposite, petiolate, ovate to elliptical or ovate-lanceolate, varying in size

and degree of glaucousness. Mature leaves alternate, broad-lanceolate to narrow-lanceolate and lanceolate, with very long petioles, dark-green, glossy, and very coarsely veined, 10-22 × 1·5-2·5 cm., and sometimes much larger. Umbels axillary, 3-flowered. Peduncles compressed to subterete, 4-7 mm. Buds strongly pedicellate (the description 'sessile' in 'Key to Eucalypts' supports my belief that *E. Dalrympleana* is a polymorphic species belonging to Group (2), narrow to broadly ovoid, 7-8 × 3-5 mm. Operculum acutely to bluntly conical, as long as the calyx-tube. Fruit pedicellate, variable in shape and size, turbinate to globose, 7-10 × 8-9 mm. Disc domed to flat. Valves strongly exsert.

Habitat: Prefers sub-alpine situations in river valleys or alluvial flats.

Distribution: Common at altitudes between 2000 and 3000 feet. Tasmania: Waddamana, Lake St. Clair, Middlesex Plains, &c. Also New South Wales and Victoria.

Affinities: With *E. rubida* and *E. viminalis.*

Hybrids: With *E. rubida* where the two meet. From impressions in the field, and a study of seedlings, there is a possibility that the species had its origin in *E. rubida* and one or more others, including *E. pauciflora.* The evidence is not strong enough yet to advance this as any more than an opinion.

25. **E. Johnstoni** Maiden (*E. Muelleri* T. B. Moore). Maiden, 1922—Crit. Rev., Pt. LVI, 280. Moore, T. B., 1886—Proc. Roy. Soc. Tas., 207. A small to medium tree, 9-12 m. Bark smooth, deciduous, blotched, and with a prevailing tone of olive-green. Juvenile leaves opposite for an indefinite number of pairs, sessile to shortly petiolate, crenulate and undulate, dark-green and glossy. Intermediate leaves alternate, petiolate, oblong-ovate to lanceolate, coriaceous and vernicose, subcrenulate, 3-6 × 2·5-6 cm. Mature leaves dark-green, vernicose, alternate, petiolate, lanceolate to narrow-falcate-lanceolate 5-10 × 1·5-3 cm. Umbels axillary, 3-flowered. Peduncles compressed to strap-shaped or triangular, broad to narrow, 4-7 mm. Buds sessile, broadly turbinate to subelliptical, angular, 3 or 4 ribbed, 8-14 × 6-10 mm. Operculum flat, markedly umbonate or ridged across the top, shorter than the calyx-tube. Fruit hemispherical to broadly turbinate, 2-3 ribbed or narrowly winged, 7-10 × 10-14 mm. Disc domed, prominent. Valves large and exsert.

There is little doubt that the descriptions of this species have been based on the Mt. Wellington forms, but T. B. Moore included the very similar *E. subcrenulata* in the distribution. A study of a large quantity of material selected for as wide a range in size of fruit as possible reveals the existence of two forms: one, a large fruited type, tends in leaves and shape of buds towards *E. globulus*; the other shows transit to *E. subcrenulata.* The above measurements in the description indicate a very wide spread in the characters chosen. It is here suggested that *E. Johnstoni* has arisen from *E. globulus* and *E. subcrenulata*, and is in process of becoming stabilized. A possible future course might be to establish two biotypes, or by a process of future intraspecific hybridization evolve a single biotype intermediate between the abovementioned forms. In support of this suggestion, which is based upon a close comparison between reproductive parts of *E. subcrenulata* and *E. Johnstoni*, it may be mentioned that, as far as can be ascertained, *E. Johnstoni* is confined to Mt. Wellington, and *E. subcrenulata* does not associate with *E. globulus*, which grows on the lower slopes of Mt. Wellington. There is apparently no *E. subcrenulata* on Mt. Wellington. In further support of the possibility, it may be added that Prof. A. L. McAulay and myself have independently concluded, on field and horticultural evidence, that the non-glaucous *E. urnigera*, confined to the south-east and south face of Mt. Wellington, has probably arisen from *E. Johnstoni* and *E. urnigera*, which latter is a markedly glaucous species on the eastern face of Mt. Wellington and in its wide distribution beyond this. The probability of an *E. globulus* component is increased by the extreme difficulty of separating some forms of *E. unialata*, an established hybrid of *E. globulus*, from the coarser fruited form of *E. Johnstoni*.

Habitat: Sub-alpine to alpine.

Distribution: As far as known at present, confined to Mt. Wellington.

Affinities: With *E. globulus*, *E. subcrenulata*, and *E. vernicosa*.

Hybrids: With *E. urnigera*.

26. **E. Simmondsi** Maiden. Maiden, 1922—Crit. Rev., Pt. LVII, 344. The following description is quoted from 'Key to Eucalypts' (Blakely): 'A tree 40-60 feet high (about 12-20 m.). Bark rough, fibrous, persistent on stem, branches smooth or ribbony. Timber pale, reputed durable. Juvenile leaves opposite for a large number of pairs, glaucous, ovate to broadly lanceolate, sessile to shortly petiolate, 5-10 × 3-5 cm. Mature leaves alternate, petiolate, coriaceous, lanceolate, 10-15 × 1-2 cm. Venation more or less longitudinal. Umbels axillary, 5-15 flowered. Peduncles terete or nearly so, 5-7 mm. long. Buds clavate, shortly pedicellate, 6-7 × 5-6 mm. Operculum hemispherical, less than half as long as the calyx-tube, obtuse or slightly umbonate. Fruits conoid to turbinate, 9-10 mm.; disc well defined, convexed, almost enclosing the short valves.

'An imperfectly known species from Smithton, Tasmania. Flowers about December'.

Distribution: The type specimen is given as collected at Smithton. I am not familiar with the trees in the field. As far as yet known confined to Tasmania.

Affinities: From the robustness and length of the pedicels, and the nature of the venation and the juvenile foliage, the suggestion is that its origin is *E. pauciflora* and one of the macrantherae, possibly *E. viminalis*. I have collected material similar to this in the Cradle Mt. area, and make the very tentative suggestion that *E. Simmondsi* is polymorphic and belongs to Group II.

27. **E. Tasmanica** Blakely. (*E. Risdoni* Hook., f., var. *E. elata* Benth., in part.) Blakely, 1934—'Key to Eucalypts', p. 214. The type description is quoted below: 'Arbor insigniter glauca, 30-70 pedes alta (circa 9-21 m.) cortice levi, deciduo. Folia juvenilia opposita, sessilia, cordato-lanceolata, connata, 3-6 cm. longa, 2·5-5 cm. lata. Folia matura alterna, petiolata, angusto-lanceolata, acuminata, 5-16 cm. longa, 1-3·5 cm. lata. Inflorescentia in umbellis axillaribus, 6-25 floris. Gemmae clavatae, glaucae, 5-6 mm. longae, 5 mm. latae, in crassos pedicellos angustatae. Operculum patelliforme, claycis tubo brevius. Antherae reniformes. Capsulae turbinatae vel subpyriformes, truncatae, pedicellatae, 9-13 mm. longae, 7-11 mm. latae.'

A study of Plate XVI will show that this description only covers part of the polymorphic ×*E. Risdelata*. The operculum in fig. 3 is not patelliform. From a study of the type description I suggest that *E. Tasmanica* Blakely is ×*E. Risdomacranthelata* in part.

Distribution: Very widely distributed throughout Tasmania, and is confined to the State.

Affinities: With *E. Risdoni.*

28. **E. unialata** Baker and Smith. (*E. viminalis*, var. *macrocarpa* Rodway.) Baker and Smith, 1912—Proc. Roy. Soc. Tas., 176. A small to medium tree, 6-12 m. Bark smooth, deciduous, white in colour, or rough lightly furrowed with kino exudations, ribbony on branches. Juvenile leaves opposite for an indefinite number of pairs, glaucous, ovate to ovate-cordate to oblong-lanceolate, 5-7 × 1·5-3 cm. or larger. Intermediate foliage petiolate, short-lanceolate to falcate-lanceolate. Mature leaves petiolate, with resemblance to those of *E. globulus* and *E. viminalis*, acuminate, dark-green, subvernicose, up to 19 × 1·5-2 cm. Umbels axillary, 3-flowered. Peduncles broad, compressed, 3-5 mm. Buds elliptical, sessile, or subsessile, green or subglaucous, 10-15 × 7-10 mm. Operculum obtusely conical to subrostrate, as long as the calyx-tube. Fruit sessile, broadly obconical, turbinate or hemispherical. Disc flat or convex, valves slightly to strongly exsert.

Habitat: Only occurs as isolated trees in associations of *E. globulus* and *E. viminalis.*

Distribution: Tasmania—Eaglehawk Neck, Grass Tree Hill, Lindisfarne, Bellerive, Mt. Nelson. Also on Port Phillip Island.

Affinities: With *E. globulus*, *E. viminalis*, and *E. Johnstoni.*

29. **E. biangularis** Simmonds. Maiden, 1927—Crit. Rev., Pt. LXVIII, 382. The following note by Simmonds appears on the label of the type specimen: 'Tree in grounds of W. D. Hunt, Invercargill, New

Zealand. In general aspect and bark, similar to *E. urnigera*. Jan. 14, 1918'. There is no record of a tree similar to this growing naturally in Tasmania. In the absence of any field notes the following description is quoted from 'Key to Eucalypts' (Blakely): 'A tree 40-100 feet high (about 12-24 m.), with a smooth deciduous bark. Timber not seen. Juvenile leaves opposite for an indefinite number of pairs, glaucous or pale-green, sessile cordate. Mature leaves alternate, petiolate, narrow to broad-lanceolate, 14-17 × 1·3-3·5 cm. Umbels axillary, 3-flowered. Peduncles strap-shaped. 10-17 mm. long. Buds turbinate, glaucous or brownish, sessile or nearly so, biangular, very warty, 20 × 13 mm. Operculum broadly conical or cap-like, warty, shorter than the calyx-tube. Anthers versatile, oblong, opening in parallel slits, gland ovate, moderately large. Fruit urceolate to campanulate, biangular, with very short compressed pedicels, 27 × 20 mm. Disc thin, somewhat doubled, the inner portion broad and convex; valves deeply enclosed (Teddington, Botanic Gardens, Christchurch, New Zealand); grown from seed imported from Tasmania'.

Affinities: The suggestion of *E. globulus* × *E. urnigera* is very strong. *E. globulus* produces an occasional hybrid with the allied *E. cordata* (see *E. globulus*, var. *Harrisoni*, in the Rodway Herbarium).

30. **E. Irbyi** Baker and Smith. Baker and Smith, 1920—Research on the Eucalypts, 2nd edition, 242. A small tree, up to 12 m., with a smooth bark, pale or ashy coloured. Juvenile leaves opposite for an indefinite number of pairs, sessile to shortly petiolate, glaucous, ovate to cordate. I have not yet been able to verify the statement 'juvenile leaves opposite for several pairs' ('A Key to Eucalypts', Blakely). Intermediate leaves alternate, petiolate, broadly lanceolate. Mature leaves alternate, petiolate, narrow-lanceolate to ovate-lanceolate, 10-20 × 1·5-2·5 cm. Umbels axillary, 3-flowered. Peduncles terete, 4-7 mm. long. Buds distinctly pedicellate to shortly pedicellate, with turbinate calyx-tube, 5-6 × 4-5 mm. Operculum shorter than calyx-tube, blunt to apiculate or subrostrate. Fruit hemispherical to sub-cylindrical, glaucous to non-glaucous, pedicellate, 7 × 7-9 mm. in diameter. Valves slightly exsert.

Habitat: Trees are isolated, and do not form pure stands, and are found only in association with *E. Gunnii* and *E. Dalrympleana*.

Distribution: Not reported outside Tasmania. Alma Tier. Similar forms can be found in the *E. Gunnii* and *E. Dalrympleana* association at Daisy Dell, in the Cradle Mt. area.

Affinities: With *E. Gunnii* and *E. Dalrympleana*. This tree, which combines the characters of both species, is of direct hybrid origin, and its hybrid character is observable even in the cotyledon stage.

31. **E. taeniola** Baker and Smith. Baker and Smith, 1912—Proc. Roy. Soc. Tas., 198. A medium tree, 12-15 m. Bark fibrous and persistent on trunk, dark-grey, furrowed, and resembling that of *E. Sieberiana*, upper branches smooth. Juvenile leaves opposite for 4-5 pairs, petiolate, narrow-lanceolate, pale-green, 10-15 × 1·5 cm. Intermediate leaves petiolate, narrow-lanceolate to falcate-lanceolate, mainly with semilongitudinal venation, a few pinnately veined. Mature leaves alternate, narrow to broad-lanceolate and subfalcate, 8-20 × 1-2·5 cm., venation semilongitudinal. Umbels axillary, 3-7 flowered. Peduncles strap-shaped, 5-12 mm. Buds clavate, pedicellate, 6-7 × 3-4 mm. Operculum hemispherical, apiculate, shorter than the calyx-tube. Fruit pedicellate, pyriform-truncate to pyriform-globose, subfalcate, 7-9 × 5-9 mm. Disc flat to oblique. Valves deeply enclosed.

Habitat: Found as isolated trees only in mixed stands of *E. salicifolia* and *E. Sieberiana.*

Distribution: Not reported outside Tasmania. St. Mary's Pass, St. Helens.

Affinities: With *E. Sieberiana* and *E. salicifolia.* There is every indication that the tree is *E. Sieberiana* × *E. salicifolia.* The hybrid character is evident at the cotyledon stage.

ACKNOWLEDGEMENTS

This work would not have been possible without the help and encouragement of many kind friends in Tasmania, Victoria, and South Australia. I desire to acknowledge gratefully my obligations to Prof. A. L. McAulay, of the University of Tasmania, for encouragement and assistance with suggestions and helpful criticism; to Mr. St. John, of the National Herbarium, Melbourne, for much valuable information regarding eucalypts common to Victoria and Tasmania; to Mr. H. H. Scott, Curator of the Queen Victoria Museum, Launceston, for placing at my disposal his valuable knowledge of wood histology, and for much time spent in the preparation of wood sections in an attempt to compile a wood key of Eucalypt species; and to Mr. R. Read, of the Public Works Department, who has rendered the most generous assistance with transport and photography. My thanks are especially due to Mr. W. F. Blakely and the Director of the National Herbarium, Sydney, for permission to examine type specimens of *E. Archeri*, *E. Simmondsi*, and *E. biangularis*. During the course of my work the most generous assistance has been afforded me by the staffs of the Tasmanian Museum and the National Herbarium, Melbourne.

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PLATE XV

Figs. **1-5 represent seedlings from *E. unialata*, components of ×*E. vimiglobulus*.**

Fig. **1.—Seedling indistinguishable from *E. globulus*.**

Fig. **2.—Leaves glaucous but narrower than those in fig. 1.**

Fig. **3.—Seedling showing leaves similar to those on specimens from Mt. Nelson labelled *E. Dalrympleana* by Maiden.**

Fig. **4.—Juvenile leaves; would match those on many trees that are at present classed as *E. viminalis*.**

Fig. **5.—Seedling indistinguishable from *E. viminalis*.**

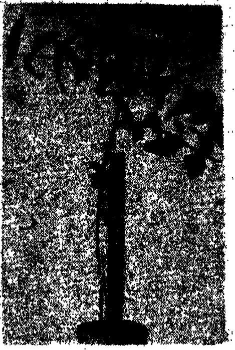
Fig. **6.—Specimens of *E. unialata*, showing capsules from which seedlings in figs. 1-5 were obtained.**

Fig. **7.—*E. globulus* with the majority of the umbels 3-fruited. Probably a component of ×*E. vimiglobulus*.**

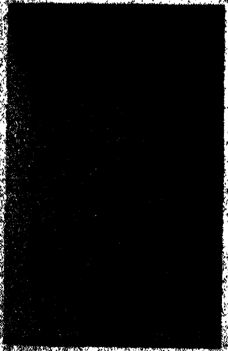
PLATE XV

1

2


3

7


5

4

6

PLATE XVI

Fig. 1.—Probably × *E. Risdocordelata,* obtained from an association of × *E. Risdelata* and *E. cordata.*

Fig. 2.— × *E. Risdomacranthelata.*

Fig. 3.— × *E. Risdopaucilata.* The figure does not indicate the semi-longitudinal venation shown in the leaves. Fruit and leaves are similar to hybrids of *E. pauciflora* and *E. salicifolia.*

Fig. 4.—A good example of × *E. Risdobliquelata.*

Fig. 5.—Typical × *E. Risdosalicilata.*

Fig. 6.— × *E. Risdomacrantherasalicilata.* Gives a swarm segregating towards × *E. Risdomacranthelata* and *E. salicifolia.*

PLATE XVI

1

2

3

6

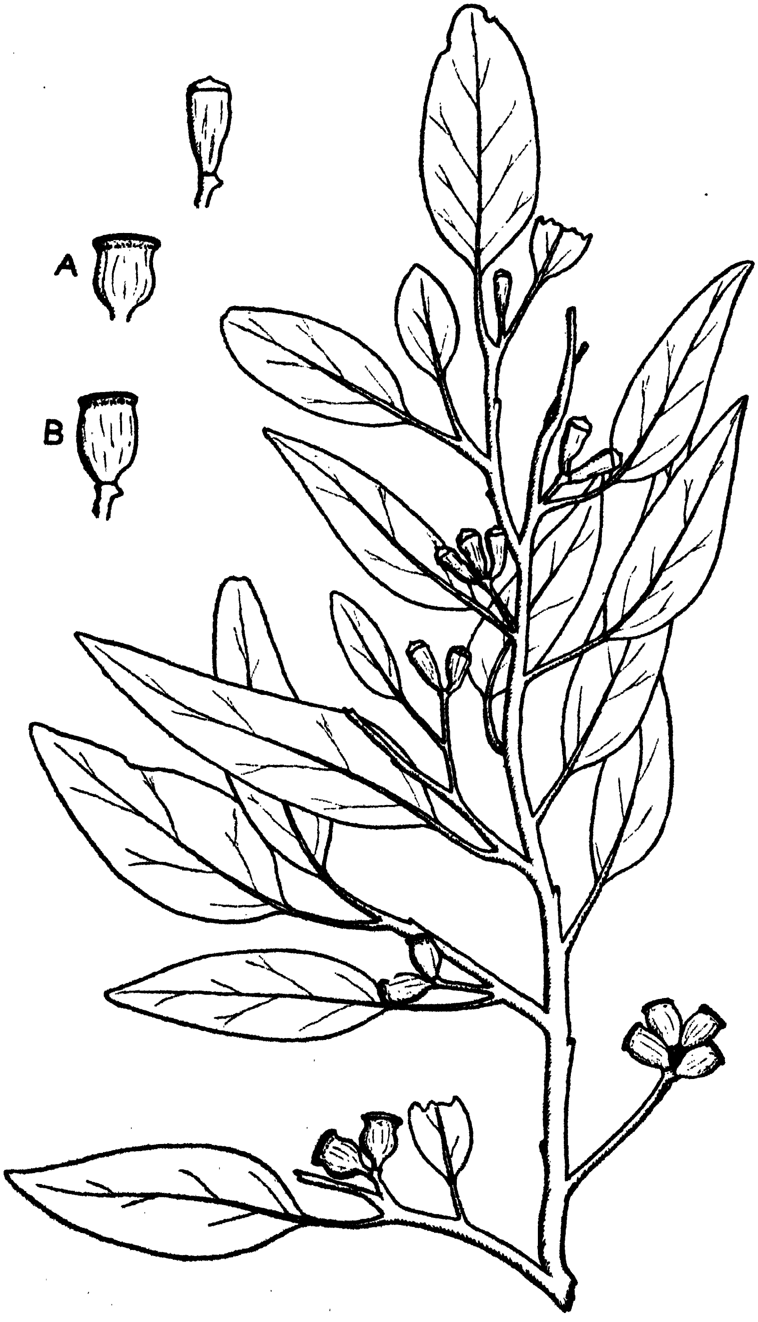
5

4

PLATE XVII

Eucalyptus divaricata

A. Immature fruit. B. Mature fruit.


A
B

PAP. & PROC. ROY. SOC. TASMANIA, 1937 (20TH MAY, 1938)

Observations on Fishes of the Family Galaxiidae
Part II

By

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(Read 8th November, 1937)

Plates XVIII-XXVII

In Part I of these Observations (Scott, 1936), devoted to a taxonomic survey of the family, with descriptions of new species, the hope was expressed that in succeeding parts it would be found possible to consider the Tasmanian Galaxiidae described prior to 1936. The present contribution contains some biometric observations on the widely distributed *Galaxias* (*Galaxias*) *attenuatus* (Jenyns), relating chiefly to frequency distribution of standard length, including seasonal variations; rate of growth; variation of proportions with growth; growth-gradients; extra-aqueous viability. Non-metrical observations on this species are reserved for a subsequent communication.

CONVENTIONS AND ABBREVIATIONS

(*a*) *Unit of Measurement.* Except where otherwise expressly noted, all linear dimensions are recorded in millimetres; and, save in a few cases in which such procedure might result in uncertainty or confusion, considerable typographic economy is achieved by the systematic omission in the body of the paper of the unit of measurement.

(*b*) *Criteria of Length.* Total length (from tip of snout to tip of normally extended caudal fin; between parallels), and standard length (from tip of snout to hypural fan; between parallels) are designated by **LT**, **LS**, respectively.

(*c*) *Groups of Material.* PC, NPC, TT denote, respectively, metrically examined material from Punchbowl Creek, from Tasmanian localities other than Punchbowl Creek, from all Tasmanian localities.

(*d*) *Mathematical Conventions and Abbreviations.* Length-classes are designated by value of midpoint of relevant interval (*e.g.*, 45 = class-value of 40 – 50). b = fractional coefficient (in simple heterogony formula $y = bx^k$). (f) = frequency in a class-interval. h = width of class-interval. k = growth-coefficient (in simple heterogony formula $y = bx^k$). Md = median: in series with even number of terms Md is taken as arithmetic mean of bracketing terms; and is not weighted. M_0 = mode; throughout crude, not weighted in short series. n = number of individuals. N_s = survival-sequence number. Q, Q_1, Q_3 = quartile deviation, first quartile, third quartile, respectively. S_k = measure of skewness (Pearson's approximate formula $S_k = \frac{3(\bar{x} - \text{Md})}{\sigma}$ used). V = coefficient of variation $\left(V = \frac{\sigma}{\bar{x}} \times 100\right)$. $\bar{x}$ = arithmetic mean. σ = standard deviation = $\sqrt{\frac{\Sigma (x - \bar{x})^2}{n}}$: no substitution of $n - 1$ for n in small series (Huxley *et al.*, 1927).

MATERIAL AND LOCALITIES

Material examined comprises upwards of sixteen hundred specimens, representing some thirty Tasmanian, and several extralimital, localities. It may conveniently be enumerated under the four headings noted below: The addition of an asterisk indicates that in the series thus marked *G.* (*G.*) *attenuatus* (Jenyns) occurs in association with *G.* (*G.*) *truttaceus* Cuvier.

(*a*) *Punchbowl Creek, Launceston.* 41 series. Locality indicated by C in accompanying map (Fig. 1). Series 11, 6/2/34; 27, 7/5/34; 36, 22/7/34; 44, 24/11/34; 45, 25/11/34; 46, 2/12/34; 55, 6/1/35; 61, 10/2/35; 70, 10/3/35; 73, 74, 7/4/35; 81, 18/8/35; 89*, 8/11/35; 90*, 10/11/35; 91*, 24/11/35; 92*, 15/12/35; 104, 16/2/36; 113, 27/9/36; 114, 4/10/36; 115*, 18/10/36: 117*, 22/11/36; 119, 31/12/36; 123, 124*, 125*, 126*, 127, 128, 31/1/37, 14/2/37, 7/3/37 (two examples on each date); 129*, 21/3/27; 132, 6/4/37; 133-138, 18/4/37, 9/5/37, 13/6/37 (two examples on each date); 139, 25/7/37; 141, 142, 10/9/37; 143, 26/9/37; 144, 6/10/37. Where two series are entered under one date, the first is from *Larnoo* section, second from Reserve section.

(*b*) *Other Tasmanian Localities.* 42 series. Localities shown by A-B, D-Z, a-b, d-e. Series 4*, Kelso (A), 22/12/33 (R. Slater); 8, marsh near Low Head (B), 22/1/34 (R. Green); 13, East Risdon (D), 17/2/34 (V. V. Hickman); 14 and 15, River Tamar, at Launceston (E), 9/3/34 and 12/3/34; 17*, Cox's Creek, Wynyard (F), 29/3/34 (J. Harrison); 18*, North Esk, at St. Leonards (G), 29/3/34 (A. L. Meston); 26, River Tamar (H), 18/4/34 (J. Tyler); 28*, Franklin (I), 26/4/34 (A. B. Gaul); 37, creek at Kimberley (J), 3/9/34 (A. Knowles); 38*, 39*, 40*, River Tamar (H), 17/9/34 (whitebait); 41*, Upper Scamander (K), 18/10/34 (A. E.

Elms); 42, South Esk, at Launceston (L), 20/11/34; 43*, Cox's Creek, Wynyard (F), 24/11/34 (J. Harrison); 50, creek at *Heazleton*, Ulverstone (M), 23/12/34; 51, Button's Creek, Ulverstone (N), 24/12/34; 52* and 53*, Cox's Creek, Wynyard (F), 27/12/34; 54*, Clayton Rivulet (C), 31/12/34; 58, Kelso (A), 29/1/35 (R. Slater); 72*, Devonport (P), 14/3/35 (A. Smith); 76, Meredith River (Q), 21/4/35 (G. V. Colchester); 82, Button's Creek, Ulverstone (N), 28/8/35; 83, creek at *Heazleton*, Ulverstone (M), 29/8/35; 84, Beattie's Creek, Forth (R), 31/8/35; 85, Don River (S), 31/8/35; 86*, creek at Spreyton (T), 1/9/35; 93, Young Town (U), 28/12/35 (R. Gardam); 95*, creek about 4 miles south of Sorell, West Coast (V), 2/1/36 (A. L. Meston); 103, Kelso (A), 17/4/35 (R. Slater); 106, North Esk, at Killafaddy (X), 20/1/35; 107, Button's Creek, Ulverstone (N), 25/12/35; 108*, Latrobe (Y), 14/9/35 (whitebait); 109*, Big Eel Creek, near Temma (Z), 6/2/36 (S. L. Larnach); 110* and 111*, Mella (a), 17/4/36 and 28/4/36 (B. Burnley); 118*, Stony Creek, near Swansea (b), 2/12/36 (G. C. McKinlay); 120*, Pieman River, at mouth (d), 23/1/37 (A. L. Meston); 140, Welcome River (e), 30/12/36 (A. L. Meston).

(*c*) *Extralimital Material.* Material from Flinders Island (not included in map, and conveniently dealt with in this section), and from several Australian and South American localities, has also been examined.

(*d*) *Tank-Series.* Specimens from various localities, the most important being Punchbowl Creek, Launceston, have been kept alive in observation tanks over a period of three years.

In Table I a dagger indicates the series is bimodal or plurimodal. Values for these series are as follows. (a) **LS.**—Series No. 13; modal classes 75, 95 [4]: 15; 75, 85, 95, 105 [2]: 41; 85, 95, 105, 115 [1]: 54; 45, 55 [7]: 58; 175, 185 [1]: 76; 105, 115 [2]: 109; 75, 95, 105 [1]: 113; 55, 65 [2]: 119; 45, 55 [7]: 135; 45, 55 [2]. (b) **LT.**—15; 85, 95, 115 [2]: 17; 55, 95 [3]: 58; 195, 205 [1]: 70; 55, 65 [15]: 76; 115, 125 [2]: 109; 95, 105, 125 [1]: 113; 65, 75 [2]: 114; 65, 75, 85 [3]: 127; 55, 65 [7]: 136; 45, 55 [8]: 110; 85, 105 [4].

SPECIFICATION OF LS, LT

LS, LT have been determined for 62 Tasmanian series, comprising 1415 individuals, from 24 localities [1]: this material is specified, first, by series (min., max., $\bar{x}$, Md, M_0, σ) in Table I, secondly, in three groups, below.

---

[1] This represents nearly 90% of Tasmanian specimens. Material not subjected to metrical examination consists essentially of tank-series, whitebait-series, and series consisting of only a single individual: further, several Punchbowl series collected otherwise than by trapping, though actually measured, are here excluded from consideration in order to secure a more representative, more nearly random, sampling of the stream-population.

TABLE I.

Galaxias (G.) attenuatus (Jenyns)

SPECIFICATION OF LS, LT: 62 SERIES, 1415 INDIVIDUALS

Material		Standard Length = LS (mm.)						Total Length = LT (mm.)					
Series No.	No. of Individuals	Min.	Max.	$\bar{x}$	Md	M_o (h = 10) No. of cases	σ	Min.	Max.	$\bar{x}$	Md	M_o (h = 10) No. of cases	σ
8	4	96·1	119·6	108·7	109·5	115 [2]	8·96	110·1	134·2	123·1	124·1	115 [2]	9·21
13	16	55·0	113·0	90·9	95·8	†	15·44	63·0	130·0	104·0	110·5	115 [6]	17·62
14	10	67·5	97·9	87·1	90·2	95 [5]	8·34	78·0	109·9	99·1	102·6	105 [6]	8·91
15	9	53·2	109·3	86·6	86·2	†	16·79	61·7	124·2	98·9	99·0	†	17·97
17	12	44·1	96·5	68·4	67·4	85 [3]	15·32	50·7	109·0	70·3	76·7	†	17·30
18	5	54·5	64·0	59·2	60·0	65 [3]	3·34	62·9	73·0	68·1	68·6	65 [3]	3·56
26	3	64·1	80·1	70·5	67·2	65 [2]	6·93	74·2	90·8	80·7	77·0	75 [2]	7·26
36*	3	74·3	85·0	78·4	76·0	75 [2]	4·70	82·5	96·1	88·2	86·0	85 [2]	5·77
37	3	70·9	83·1	78·0	80·1	85 [2]	5·19	81·9	95·2	89·6	91·6	95 [2]	5·62
41	4	81·2	112·0	97·5	98·4	†	11·19	92·7	127·4	111·6	113·1	115 [2]	12·45
43	6	68·9	108·0	94·6	96·3	95 [3]	12·58	77·6	123·0	107·0	108·2	105 [3]	14·56
45*	21	36·1	47·0	42·4	42·6	45 [16]	2·71	41·1	52·6	48·3	48·4	45 [16]	2·84
46*	32	36·5	57·8	43·8	43·1	45 [22]	5·43	42·0	65·1	49·9	49·0	45 [19]	5·84
50	9	46·1	64·0	53·0	51·3	55 [6]	5·27	53·0	72·0	60·4	59·0	55 [6]	5·48
51	33	34·9	93·2	49·2	43·4	45 [18]	15·66	40·0	106·1	55·9	49·0	45 [16]	17·80
52	78	33·4	60·2	50·1	49·6	45 [40]	4·33	38·5	69·1	57·1	56·5	55 [51]	4·96
53	15	42·6	57·0	49·6	48·2	45 [9]	4·13	49·0	64·6	56·5	55·9	55 [10]	4·89
54	29	40·6	88·3	59·2	60·1	†	11·27	46·0	100·5	68·1	68·9	65 [8]	10·95
55*	85	38·0	81·9	48·7	47·8	45 [46]	8·10	43·5	92·2	55·4	53·8	55 [29]	9·12
58	2	172·0	185·0	178·5	178·5	†	6·50	192·0	207·0	199·5	199·5	†	7·50
61*	43	37·5	72·0	47·4	44·5	45 [27]	8·81	43·0	82·0	54·2	51·0	45 [19]	8·94
70*	48	36·0	87·0	55·5	55·4	55 [18]	10·04	41·5	99·0	64·3	62·6	†	11·05
73*	29	39·0	88·0	54·4	51·0	55 [12]	11·75	45·0	100·0	62·6	60·0	55 [13]	13·35

74*	25	41·6	71·9	51·2	50·0	45 [12]	7·24	48·0	82·0	58·5	58·0	55 [13]	8·06
76	6	98·0	124·0	109·6	110·0	†	8·87	113·5	145·0	126·3	126·0	†	10·60
81*	11	44·7	77·1	57·7	58·0	45 [4]	11·86	50·5	87·6	65·9	66·6	55 [5]	13·32
82	33	36·6	74·2	46·2	41·2	45 [15]	9·34	12·3	84·2	52·6	46·5	45 [23]	10·84
83	3	71·5	87·1	78·1	75·6	75 [2]	6·60	83·1	100·3	90·2	87·2	85 [2]	7·34
84	27	31·1	79·7	42·1	40·1	35 [13]	9·41	35·8	90·1	47·8	45·4	45 [24]	11·30
86	9	48·0	72·1	55·3	52·1	55 [4]	7·69	56·0	82·6	63·8	60·1	55 [5]	8·63
89*	33	33·5	51·5	40·4	39·0	35 [19]	4·72	38·8	58·5	45·4	44·0	45 [26]	5·34
90*	10	38·3	89·0	47·5	40·0	35 [5]	14·67	43·5	98·5	53·8	45·3	45 [6]	15·72
91*	55	34·1	88·8	43·1	41·5	35 [26]	9·45	39·5	99·0	49·3	47·2	45 [34]	10·74
92*	35	33·5	92·6	50·4	41·2	35 [16]	17·70	37·9	106·7	58·0	47·7	45 [19]	20·44
93	5	75·7	98·4	88·7	90·6	95 [3]	8·63	87·3	109·6	100·2	102·0	105 [3]	8·81
95	5	47·7	109·5	87·2	100·1	105 [3]	27·24	56·3	124·5	96·3	114·8	125 [2]	30·60
100	25	35·6	48·7	39·5	38·6	35 [19]	2·76	41·8	55·7	45·2	44·5	45 [23]	3·30
106	34	37·5	70·4	52·6	54·1	55 [16]	8·83	42·5	81·1	59·9	60·9	65 [13]	8·54
107	31	39·7	92·5	51·3	47·6	45 [20]	11·13	45·1	103·4	57·5	54·0	55 [18]	12·42
109	3	79·9	106·0	93·8	95·4	†	10·74	94·3	121·1	108·2	109·3	†	10·96
110	73	64·0	133·8	92·9	100·5	105 [17]	17·81	72·5	151·5	107·6	114·0	125 [15]	19·87
111	14	34·6	123·2	62·1	56·1	55 [4]	25·58	40·1	138·4	71·9	64·5	65 [5]	28·75
113*	5	53·5	79·0	64·2	65·2	†	9·23	62·0	89·0	73·3	74·5	†	9·29
114*	11	51·6	84·6	65·6	62·1	65 [4]	9·54	59·0	93·0	74·5	70·5	†	10·14
115*	43	34·4	90·1	42·5	39·7	35 [29]	9·98	40·3	104·0	48·6	45·2	45 [39]	11·32
117*	57	36·5	65·3	42·8	41·8	45 [36]	4·28	41·7	73·9	48·8	47·8	45 [39]	5·91
119*	16	40·3	65·5	51·2	50·3	†	6·92	46·2	74·5	58·7	57·6	55 [7]	7·88
123*	31	41·0	90·7	58·1	57·2	55 [14]	10·77	47·0	102·0	66·0	64·6	65 [14]	11·70
124*	48	37·5	80·8	47·3	44·5	45 [26]	7·73	43·9	93·0	54·1	51·3	45 [20]	8·94
125*	32	36·4	62·2	49·1	51·4	55 [16]	6·65	42·1	70·8	56·8	55·1	55 [16]	7·50
126*	21	35·1	65·0	42·1	42·5	45 [13]	6·84	41·0	74·1	50·4	48·0	45 [14]	7·32
127*	20	39·0	80·1	56·4	52·1	55 [9]	11·92	44·9	91·9	64·7	60·2	†	13·49
128*	32	36·0	46·0	40·1	39·0	35 [20]	3·13	41·5	52·6	46·1	45·0	45 [26]	3·17
129*	51	33·6	83·1	44·4	42·5	45 [27]	8·97	39·0	95·9	51·9	48·6	45 [25]	10·24
133*	17	45·1	66·5	54·7	58·3	45 [7]	7·00	51·8	76·2	62·4	60·7	55 [7]	7·79
134*	20	37·2	50·1	42·6	42·7	45 [14]	3·24	43·2	57·3	48·4	48·5	45 [14]	3·61
135*	5	43·2	63·1	53·4	52·8	†	7·66	49·6	71·9	61·3	61·2	65 [2]	8·44
136*	21	37·6	58·5	47·1	46·5	45 [11]	6·01	43·2	67·1	54·0	53·2	†	6·87
137*	7	38·7	47·0	44·1	44·6	45 [6]	2·48	44·3	54·0	50·3	50·4	55 [5]	2·79
138*	22	35·4	54·8	42·7	41·5	45 [12]	4·57	41·0	62·8	48·1	48·8	45 [17]	5·52
139*	13	42·7	67·5	48·9	47·6	45 [10]	6·63	48·4	77·0	56·2	55·0	55 [8]	7·47
140	12	59·9	107·4	87·2	91·2	75 [4]	13·98	69·0	121·0	99·1	102·8	†	15·35

(*a*) *Punchbowl Creek.* PC[1] material comprises 32 series, 897 specimens. All series trapped. Statistics of **LS**, **LT** for separate series exhibited in Table I. For total PC material we have, as regards **LS**, min. 33·5, max. 92·6, $\bar{x}$ 47·94, Q_1 39·66, Md 43·93, Q_3 51·62, M_0 (with $h = 10$) 45 (429 cases), σ 10·445: as regards **LT**, min. 37·9, max. 106·7, $\bar{x}$ 55·02, Q_1 45·40, Md 50·23, Q_3 59·18, M_0 45 (397 cases), σ 11·865. **LS** deciles are 37·4, 39·0, 40·4, 42·1, 43·9, 46·4, 49·8, 53·8, 60·2.

This material is peculiarly appropriate for the investigation of frequency distribution, and, in spite of the absence of very small and of very large individuals, almost certainly provides, at least between the limits $33 \leq \textbf{LS} \leq 92$, a more characteristic sample of the general population than that afforded by NPC and TT material.

Its more homogeneous and typical character is attributed, first, to the single source of the material;[2] secondly, to reasonably regular distribution over the various months of the season, and thirdly, and, in practice, most notably, to the method of collection, namely trapping,[3] which results in the elimination, or at least the great reduction, of the differential effects of angling and hand-netting, reliance on which methods commonly tends—partly on the ground of mere physical facility, and partly from conscious and unconscious selection by the collector—to the collecting in unduly high proportions of individuals of large or moderate size (*cf.*, for instance, Regan's British Museum material, noted below).

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[1] The abbreviations PC (= Punchbowl Creek), NPC (= Tasmanian; Non-Punchbowl Creek), TT (= Total Tasmanian) denote only the metrically examined material, not the total material, from these localities.

[2] Punchbowl Creek, 3-4 miles long, rises among the hills westward of Young Town, and enters the North Esk River, here subject to a rise and fall of tide totalling about six feet, a few chains south of the southern boundary of *Ravenscraig*, the Scotch College estate, the northern side of which lies within 100 yards of the boundary (1935) of the City of Launceston.

Portion of the creek studied, approximately one mile, is conveniently divided into four sections, which, proceeding in direction of flow (eastward), are as follows. (1) First Reserve Section—in Punchbowl Reserve, about 280 yards long, above (west of) waterfall (about 30 feet high); no fish have been observed here. (2) Second Reserve Section—about 640 yards long, below waterfall; always with fish; material designated Reserve collected in this section. (3) *Larnoo* Section—about 540 yards long, running through Mr. H. W. A. von Steiglitz's estate *Larnoo*; greater part of material (specified as *Larnoo*) secured here. (4) *Queechy*; section—divided from (3) by large culvert beneath Penquite Road; about 340 yards long, in Mr. W. Fraser's estate *Queechy*.

[3] Very satisfactory results are obtained with a flywire minnow trap in the form of an open cylinder, about 2 feet long and 1 foot in diameter, fitted at either end with an inwardly directed cone, about 8 inches high, with the apex truncated to provide an entrance 1½-2 inches in diameter; bait (one or two worms) suspended from wire hook hanging down into middle of trap; attach 2 or 3 yards of cord to one end of trap for retrieving; immerse (bare submergence is usually advisable) for 5-10 minutes, with long axis in direction of flow of stream; a door for extraction of fish may be provided, if desired.

(*b*) *Other Tasmanian Localities.*—NPC material comprises 30 series, 518 specimens, from 22 localities. Statistics of **LS**, **LT** for separate series exhibited in Table 1.

For total NPC material we have, as regards **LS**, min. 31·1, max. 185·0, $\bar{x}$ 63·98, Q_1 44·55, Md 53·89, Q_3 83·13, M_0 (with $h = 10$) 45 (147 cases), σ 25·222 : as regards **LT**, min. 35·8, max. 207·0, $\bar{x}$ 71·23, Q_1 50·96, Md 61·50, Q_3 92·67, M_0 55 (120 cases), σ 28·427. **LS** deciles are 38·6, 42·0, 46·4, 49·3, 53·9, 60·2, 76·4, 92·1, 104·6.

(*c*) *Total Tasmanian Material.*—TT material comprises 62 series, 1415 specimens, from 30 localities. Statistics of **LS**, **LT** for separate series exhibited in Table 1.

For TT material as a whole we have, as regards **LS**, min. 31·1, max. 185·0, $\bar{x}$ 53·81, Q_1 40·50, Md 46·73, Q_3 57·06, M_0 (with $h = 10$) 45 (573 cases), σ 35·049: as regards **LT**, min. 35·8, max. 207·0, $\bar{x}$ 60·96, Q_1 46·05, Md 53·58, Q_3 65·16, M_0 45 (508 cases), σ 35·735. **LS** deciles are 37·7, 39·5, 41·5, 43·8, 46·7, 50·0, 54·4, 61·0, 83·3.

COMPARISON OF PC, NPC, TT MATERIAL

These three groups of PC, NPC, TT material may profitably be compared by means of percentile curves[1]: those for **LS**, based on the deciles, are shown in Fig. 2.

Note general regularity of increase, proceeding to right of the ogive, of TT over PC values; with sharp ascent for max. value, largely traceable to influence of Series 58.

For PC, $Q_{LS} = 11·96$, $Q_{LT} = 13·78$; for NPC, $Q_{LS} = 38·58$, $Q_{LT} = 41.71$; for TT, $Q_{LS} = 16·56$, $Q_{LT} = 19·11$. High values of the interquartile intervals for NPC material are in part attributable to varied modes of collection, a factor whose influence in TT material is largely counteracted by the homogeneity of the numerically preponderant PC element.

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[1] Percentile curve is here used for a curve having as ordinate the value of the percentile, and as abscissa the percentile index, p. The term is also often applied to a cumulative frequency curve, in which integrated frequency is represented by the ordinate, and values of the variable by the abscissa. It is more in harmony with mathematical convention to name a curve according to what is represented by the ordinate, and it is hence desirable (Holzinger, 1928) to restrict Percentile Curve to the connotation with which it is here employed.

Assuming—probably with a fair degree of accuracy—that specimens of $\bar{x}_{LS} \leq 60$ are one year old, or less; specimens of $60 > \bar{x}_{LS} > 75$ are in their second year; and specimens of **LS** > 80 are three years old, or more, we obtain from Fig. 2, by method of percentile ranks, the following results:—One year old or less: PC 89%, NPC 60%, TT 78%. In second year: PC 5%, NPC 9%, TT 8%. In third, or later, season: PC 4%, NPC 26%, TT 11%.

Observe also that approximate percentage of material with **LS** greater than max. of PC material is 20% for NPC, 9% for TT, material.

Extreme Variates.

(*a*) *Maximum.* The maximum length among the 50 specimens noted by Regan (1906, p. 369) is 170, recorded in the case of his No. 5, the type of *G. punctatus* Günther, from Eastern Creek, and his No. 21, a specimen from Tasmania, presented by Sir J. Richardson.

Clarke (1899, p. 80) observes of specimens of these species: 'They very seldom exceed a total adult length of 6 inches. The longest ever observed by me in either of the other colonies or New Zealand in an experience of forty-four years was barely 7 inches in length. Average length of adult fish, 4½ inches to 5 inches (total).'

The largest individuals I have encountered (Nos. 58/1, 2; **LS** 185·0, 172·0; **LT** 207·0, 192·0) were secured by Mr. Reg. Slater, in January, 1935, from a waterhole about 12 feet square, on his property *Paranaple*, Kelso, Northern Tasmania, and were, it is believed, two of a number placed there about four and a half years previously. The larger specimen was observed lying dead in the water, having apparently died a natural death, the smaller was netted alive. Other dimensions of these examples are (No. 58/1 noted first): head 31·0, 29·0; eye 6·0, 6·5; snout 7·25, 7·5; interorbital width 19·0, 14·0; depth of body 36·0, 30·0; thickness of body 28·5, 25·5; length to dorsal 139·0, 136·0; base of dorsal 20·0, 16·0; longest dorsal ray 20·5, 16·5; base of anal 30·0, 32·0; longest anal ray 21·5, 16·5; length of pectoral 21·0, 19·0; length to pelvic 90·0, 82·0; length of pelvic 20·0, 19·0; length of caudal peduncle, 16·0, 14·0; depth of caudal peduncle 15·0, 13·25.

Five next largest specimens are Nos. 110/7, 9, 29, 13 and No. 76/1, which have **LS** 133·8, 126·5, 126·0, 124·7, 124·0, and **LT** 151·6, 143·0, 143·5, 143·4, 145·0, respectively.

That the dimensions of Nos. 158/1, 2 are quite exceptional, is indicated by the magnitude of the interval separating No. 158/2 and No. 110/7 (interval for **LS** = 38·2, for **LT** = 40·5), resulting in the occurrence in the **LS** frequency table of 10-mm. classes for TT material (Fig. 6) of a hiatus (the only one present) extending over three length-classes: *cf.* also Table II.

(*b*) ***Minimum.*** The minimum length in Regan's material (which consists mainly of rather large specimens of average **LT** of the order of 80) is 55, occurring among 8 specimens of **LT** 55-60 from Magellan. This is far from small: of PC material 63 %, of TT 53 %, is of this length, or less.

McCulloch (1915), in giving an account of the immigration of *G.* (*G.*) *attenuatus* from the sea into a stream crossing the beach at Freshwater Bay, near Sydney, N.S.W., observed on 31st August, 1914, describes and figures immediately postlarval specimens, one of which is noted as having **LT** 38.

Minimum length among TT material is afforded by No. 84/12 (NPC), with **LS** 31·1, **LT** 35·8, the next smallest specimen being No. 52/73 (NPC), with **LS** 33·4, **LT** 38·5. Other dimensions of these examples are (No. 84/12 noted first): head 5·0, 5·5; eye 1·1, snout 1·4, 1·4; interorbital width 2·3, 2·0; depth of body 3·3, 2·8; thickness of body 2·5, 2·6; length to dorsal 21·4, 24·5; base of dorsal 3·9, 3·8; longest dorsal ray 2·2, 2·3; base of anal 4·5, 4·5; longest anal ray 2·2, 2·3; length of pectoral 3·0, 3·5; length to pelvic 15·5, 15·5; length of pelvic 2·5, 2·5; length of caudal peduncle 5·1, 3·5; depth of caudal peduncle 2·0, 1·6.

Other TT specimens of **LS** $<$ 34·0 are No. 92/18 (PC), **LS** 33·5, **LT** 37·9; No. 89/18 (PC), **LS** 33·5, **LT** 38·8; No. 129/1 (PC), **LS** 33·6, 39·0.

The difference in LS, amounting to 2·4, between No. 84/12 and the smallest individuals among PC material (Nos. 92/12, 89/18) is probably attributable to the collection of No. 84/12 at a locality (Beattie's Creek, near Forth, about 1·5 miles from sea) nearer the coast, and hence at an earlier stage in the inland migration.

RELATIVE VALUE OF LL, LT CRITERIA

As a measure of general length of a fish, LS is, of course, morphologically superior to LT, the latter dimension including a factor, length of caudal fin (LT–LS), relating merely to an appendage collinear with the main body-axis, and hence introducing an element subject to individual variation. Curiously enough, though the contrary might

confidently be anticipated, the determination of **LS** is made in practice more readily and satisfactorily than that of **LT**, the posterior limit of the former, the hypural joint, being clearly indicated by a very nearly vertical line, normally emphasized by a narrow bar of dark pigment, whereas the latter, delimited posteriorly by the tip of the longest caudal ray, is sometimes determinable in preserved specimens only with some difficulty, on account of greater or lesser deformation and rigidity in the caudal fin, and always involves the spreading of the fin to a normal full fan (a matter of personal judgment), in order to obviate the error of arc that is otherwise introduced.

That the determination of **LS** is more consistent in actual practice than that of **LT** is shown by a comparison of the dispersions exhibited by the two quantities, due regard being paid to the relative magnitudes. In general we find $v_{\mathrm{LT}} > v_{\mathrm{LS}}$.

Throughout the present paper, therefore, we shall henceforth adopt, and in general confine ourselves to, **LS** as a measure of general length, recording **LT** occasionally only for special purposes (*e.g.*, for comparison with data published elsewhere).

LT A LOGARITHMIC FUNCTION OF LS

The value of the ratio **LT/LS** varies with absolute size of the fish: see, under *Growth-Curves* below, equation of relative growth of length of caudal fin (**LT-LS**).

A convenient approximation, derived directly from values of $\bar{x}_{\mathrm{LS}}$, $\bar{x}_{\mathrm{LT}}$ for PC, NPC, TT groups, is

$$\log \bar{x}_{\mathrm{LT}} = 1\cdot 03 \log \bar{x}_{\mathrm{LS}}.$$

LARVAL CHARACTERS

(*a*) *Non-Metrical.* McCulloch (1915) has well described, and figured, larval specimens secured when entering a stream near Sydney from the sea on 31st August, 1914: my own observations suggest the following extensions and emendations.

I have previously (Scott, 1936, p. 87) independently observed, and discussed the taxonomic significance of, the upward deflection of the last vertebra, noted by McCulloch in his examples.

'Caudal rays blackish, the others transparent' (McCulloch, 1915, p. 48). Many of my specimens of **LS** < 40, and a few of greater **LS** (up to 47·0), show several distinct rows of spots, mainly on rays, forming distinct forwardly concave, dark arcs on anterior half, or more, of caudal. Similar curved pigment-bands occur among Tasmanian species in, *e.g.*, adult *G.* (*G.*) *affinis* Regan—though not mentioned or figured by Regan (1906, p. 380 and pl. X, fig. 1)—*Saxilaga* (*S.*) *cleaveri* (Scott), *S.* (*S.*) *anguilliformis* Scott. It seems not unlikely that their presence is a primitive family character, retained in the case of *G.* (*G.*) *attenuatus* only in the larval phase.

The **LS** to which general transparency, accompanied by larval pattern of small spots as described by McCulloch, persists, varies considerably, even in individuals of the same sample: its retention (observable in the majority of cases in samples of the major vernal immigration) in individuals that have travelled more than 40 miles inland to Punchbowl Creek is noteworthy. Generally speaking, transparency ceases at about **LS** 40, but well-marked ground-pigmentation may occur (*e.g.*, No. 128/12) at **LS** 36·1, or may be delayed (*e.g.*, No. 86/3) to **LS** 55·6 (note the possible significance of this long retention of larval facies in connexion with status of *G.* (*G.*) *gracillimus* (Canestrini) discussed below).

All specimens of Series 85 (near mouth of Don River; 31/8/35) possessed a pit or furrow indicating the point of absorption of the yolk-sac, and, just internal to, and dorsad of, this depression a bright red spot, formed by a subspherical vascular plexus, conspicuously visible through the transparent abdominal wall. Evidence of the location of the yolk-stalk, in the shape of midventral furrows or irregular depressions, and of a persistant rete is occasionally traceable in specimens entering Punchbowl Creek about October.

The striking similarity of both non-metrical and metrical characters of larval *G.* (*G.*) *attenuatus* (Jenyns) and those given for *G.* (*G.*) *gracillimus* (Canestrini) suggests the desirability of further investigation of the status of the latter species: *cf.* comments on this point long ago made by Regan (1906, p. 370).

(*b*) *Metrical.* Metrical characters of larval and immediately post-larval phases may be gathered from data given elsewhere in this paper: *cf.*, under EXTREME VARIATES, dimensions of individuals of **LS** 31·1, 33·4; also, under VARIATION OF PROPORTION WITH GROWTH, Table III (38·93, 45·20, **LS**-classes), and GROWTH-CURVES, *passim.*

Frequency Distribution of LS

1 *mm.-Classes.* With $h = 1$, PC, NPC, TT material is distributed, as regards **LS**, over 60, 155, 155 classes; as regards **LT**, over 70, 173, 173 classes, respectively. Data for **LS** recorded in Table II. For compactness, length-classes are not listed in table in unitary succession in region of extreme variates, only those for which there are entries being specified: PC and NPC data only recorded, TT values being obtainable, if required, by addition.

TABLE II.

G. (G.) attenuatus (Jenyns)

FREQUENCY DISTRIBUTION OF LS FOR PC, TT MATERIAL, $h = 1$ mm.

Length-Class (mm.)	No. of Individuals				Length-Class (mm.)	No. of Individuals				Length-Class (mm.)	No. of Individuals			
	LS		LT			LS		LT			LS		LT	
	PC	TT	PC	TT		PC	TT	PC	TT		PC	TT	PC	TT
31·5	—	1	—	—	69·5	2	3	11	18	107·5	—	4	—	1
32·5	—	—	—	—	70·5	2	10	7	10	108·5	—	4	—	3
33·5	3	4	—	—	71·5	6	10	6	7	109·5	—	4	—	11
34·5	3	6	—	—	72·5	5	7	5	10	110·5	—	1	—	3
35·5	16	20	—	1	73·5	2	7	6	10	111·5	—	4	—	4
36·5	21	25	—	—	74·5	2	5	5	6	112·5	—	3	—	4
37·5	28	42	1	1	75·5	2	6	3	6	113·5	—	2	—	1
38·5	45	59	1	2	76·5	2	5	4	4	114·5	—	4	—	3
39·5	64	83	8	3	77·5	1	5	1	5	115·5	—	1	—	3
40·5	66	81	8	13	78·5	1	5	4	7	116·5	—	1	—	3
41·5	52	66	16	19	79·5	3	6	—	4	117·5	—	1	—	1
42·5	55	70	25	37	80·5	3	6	2	6	118·5	—	—	—	3
43·5	57	65	40	51	81·5	2	8	4	8	119·5	—	1	—	6
44·5	42	48	63	79	82·5	1	8	8	11	120·5	—	2	—	1
45·5	39	60	43	58	83·5	1	4	2	5	121·5	—	—	—	4
46·5	35	46	61	81	84·5	2	4	—	4	122·5	—	1	—	3
47·5	30	43	50	57	85·5	1	1	3	4	123·5	—	3	—	3
48·5	23	44	47	56	86·5	2	4	2	9	124·5	—	2	—	4
49·5	30	50	44	57	87·5	1	4	1	5	125·5	—	—	—	2
50·5	24	36	39	43	88·5	2	5	1	2	126·5	—	2	—	2
51·5	28	41	34	47	89·5	1	6	1	3	127·5	—	—	—	3
52·5	21	33	27	39	90·5	3	6	2	6	128·5	—	—	—	1
53·5	25	35	30	41	91·5	—	2	2	4	129·5	—	—	—	3
54·5	15	24	27	39	92·5	1	3	4	7	130·5	—	—	—	3
55·5	10	21	16	32	93·5	—	4	1	9	131·5	—	—	—	3
56·5	17	26	26	45	94·5	—	2	—	4	132·5	—	—	—	1
57·5	19	31	22	82	95·5	—	9	2	4	133·5	—	1	—	—
58·5	15	22	26	40	96·5	—	5	1	3	134·5	—	—	—	1
59·5	12	16	19	28	97·5	—	4	1	1	137·5	—	—	—	1
60·5	10	17	26	36	98·5	—	6	1	3	138·5	—	—	—	2
61·5	13	17	15	26	99·5	—	2	3	5	139·5	—	—	—	1
62·5	5	8	13	23	160·5	—	5	1	6	140·5	—	—	—	2
63·5	5	8	11	21	101·5	—	3	—	3	143·5	—	—	—	3
64·5	3	10	15	24	102·5	—	2	1	6	145·5	—	—	—	1
65·5	10	11	15	27	103·5	—	3	—	2	151·5	—	—	—	1
66·5	4	6	15	20	104·5	—	6	2	2	172·5	—	1	—	—
67·5	2	5	12	14	105·5	—	3	—	4	185·5	—	1	—	—
68·5	2	6	9	13	106·5	—	2	1	4	192·5	—	—	—	1
										207·5	—	—	—	1

With $h = 1$, $M_{o_{LS}}$ for PC, NPC, TT material occurs in the following classes:—40·5 (66 cases); 45·5, 48·5 (each 21 cases); 39·5 (83 cases); $M_{o_{LT}}$ in 44·5 (63 cases); 46·5 (20 cases); 46·5 (81 cases), respectively.

For the investigation and the construction of histograms $h = 1$ gives too fine a grouping (note, *e.g.*, two values for $M_{o_{LS}}$ in NPC material above): results of employment of larger class intervals are discussed below.

PC Material. With $h = 3$, the 20 classes 34, 37..91 yield (f_{LS})=22, 94, 182, 154, 104, 77, 74, 42, 46, 28, 18, 8, 10, 9, 5, 7, 4, 5, 4, 4. Modal class is thus 40. Frequency histogram shown in Fig. 3. The curve is mesokurtic. The decrease in height of successive rectangles is not maintained in classes > 55. With $h = 5$, giving the 13 classes 32·5, 37·5..92·5, with (f_{LS}) giving 6, 174, 272, 157, 113, 73, 36, 20, 17, 9, 9, 10, 1, the right limb approximates closely to a smooth descending curve (Fig. 4). The PC histogram for LS with $h = 6$ is implicit in Fig. 5, where PC values are represented by stippled rectangles equivalent to TT – NPC: similarly for $h = 10$ in Fig. 6.

Examining the histogram for $h = 3$ (Fig. 3), we see the distribution has a marked positive skew. Using Pearson's approximate measure of skewness $S_k = \frac{3(\bar{x} - M_d)}{\sigma}$, we have $S_k = \frac{3(47 \cdot 94 - 43 \cdot 93)}{10 \cdot 45} = 1 \cdot 15$.

With $h = 3$, the 25 classes 34, 37..106 give $(f_{LT}) = 0$, 2, 27, 128, 154, 130, 91, 69, 67, 54, 41, 36, 24, 16, 8, 6, 14, 5, 3, 8, 3, 3, 4, 3, 1. Wit $h = 5$, the 16 classes 32·5, 37·5..107·5 give $(f_{LT}) = 0$, 5, 152, 245, 157, 109, 80, 62, 29, 12, 16, 8, 9, 8, 4, 1.

TT Material. This includes sufficient specimens, exhibiting an interval between extreme variates about 2·5 times that of PC material, to permit of the reasonably satisfactory use of a class"interval twice that employed in the case of PC. With $h = 6$, we have 26 classes, 32·5, 38·5..182·5 with $(f_{LS}) = 30$, 356, 322, 239, 140, 71, 40, 35, 37, 24, 26, 25, 20, 18, 8, 8, 2, 1, 0, 0, 0, 0, 0, 1, 0, 1. Modal class = 44·5. Histogram shown in Fig. 5 (total rectangles, both black and stippled portions). The curve, which does not exhibit successive decrease of (f_{LS}) in classes > 68·5, is more leptokurtic than that for PC material (Fig. 5, stippled areas). With $h = 10$ (Fig. 6), the 16 classes 35, 45..185 give $(f_{LS}) = 240$, 573, 285, 91, 66, 50, 43, 36, 18, 10, 1, 0, 0, 0, 1, 1, the histogram thus exhibiting continuous decrease of ordinate values between M_o (45 class) and 135 class, to the right of which occurs a hiatus of three classes, followed by two classes (175, 185) each with a single entry.

Using the approximate measure of skewness employed above, we find that the **LS** histogram of TT material yields $S_k = \frac{3\,(58\cdot81 - 46\cdot73)}{18\cdot86} = 1\cdot92$, the skewness being positive.

With $h = 6$, the 30 classes 32·5, 38·5..206·5 give $(f_{\mathrm{LT}}) = 1$, 38, 363, 283, 216, 157, 82, 41, 41, 27. 34, 21, 19, 26, 19. 17, 15. 3, 8, 1. 1. 0, 0, 0, 0, 0, 0, 1. 0, 1. With $h = 10$, the 18 classes 35, 45..205 give $(f_{\mathrm{LT}}) = 7$, 508. 386, 222, 69. 57, 46. 42, 31, 26, 12, 6, 1, 0, 0, 0, 1, 1.

NPC Material. Since NPC = TT − PC, values for (f_{NPC}) for all classes of **LS** and **TT** here considered may be obtained from data above. Frequency distribution of NPC with $h = 6$, $h = 10$ is exhibited in Fig. 5 and Fig. 6, respectively (black areas). Within the **LS** and **LT** ranges in which NPC and TT differ (*i.e.*, range of PC), the former is irregular. NPC provides the most platykurtic curves of the three groups. For investigation of frequency distribution NPC is less significant than either PC or TT, partly from numerical inferiority, partly in view of the fact that only an insignificant portion of the material has been trapped.

For NPC material **LS** skewness (positive) is $S_k = \frac{3\,(63\cdot98 - 53\cdot89)}{25\cdot22} = 1\cdot20$.

Seasonal Variation in Frequency in Punchbowl Creek

As might be anticipated, an investigation of the seasonal variation in frequency provides interesting data regarding migration and rate of growth.

Material. Comprises 30 series from Punchbowl Creek, consisting of 897 specimens. Extends over a period of approximately three years, from 25th November, 1934, to 6th October, 1937, embracing four major vernal immigrations. To take in the vernal immigration of 1937 two additional series, not included in PC material, and thus not specified in Table I, are considered. These are Series 143 (sample W), Punchbowl Creek, *Larnoo* Section, 10 specimens, 26/9/37; for **LS**, min. 43·1, max. 85·6, $\bar{x}$ 65·4, Md 64·6, σ 11·09; for **LT**, min. 49·0, max. 92·0, $\bar{x}$ 72·9, Md 71·6, σ 11·53; Series 144 (sample X), Punchbowl Creek, *Larnoo* Section, 57 specimens, 6/10/37; for **LS**, min. 37·8, max. 75·0, $\bar{x}$ 46·9, Md 41·9, σ 9·45; for **LT**, min. 43·4, max. 85·4, $\bar{x}$ 53·8, Md 49·2, σ 10·73.

Method. Seasonal frequency polygons,[1] with frequency expressed as a percentage, are shown in Fig. 7, A—X, (f_{LS}) being represented by an unbroken line. The most striking features of the distribution are best brought out with $h = 10$: the disadvantageous effects of the arbitrary incidence of such a coarse grouping are somewhat diminished by the graphing, in dotted lines, of (f_{LT}) as a percentage.

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[1] The chief theoretical disadvantage of the frequency polygon as compared with the histogram, namely, its suggestion that all variates in a class are concentrated at the class-centre, may be regarded, for our present purpose of visual representation, as being rather a practical advantage than otherwise.

Detailed analyses of these series have been made, and have yielded some very interesting results: these are, however, too lengthy for inclusion here, and the following discussion is confined to a summary of the more striking features revealed.

Samples S, W, X, Y are from the *Larnoo* Section of the Creek. Samples P, Q, R, T, U, V are seven pairs of series collected on same day in *Larnoo* and Reserve Sections of Creek: in the case of such pairs, *Larnoo* series is graphed first, with suffix L (*e.g.*, P_L), followed first by Reserve series (P_R), and then by pooled result (P_P).

Migrations. The most conspicuous migration is a vernal one, occurring about October.[1] Samples taken at this time show mode in 35 class: dispersion is small, due to the predominance of the migrating juvenile population, the advent of which results in the greatest density of individuals in the Creek at any period of the year.[2]

In 1935 the vernal immigration occurred between 18th August and 8th October. Thus sample G, on the former date, shows a somewhat platykurtic curve, indicative of large dispersion ($\sigma_{LS} = 11 \cdot 86$, a value greater than σ_{LS} for whole PC material), and showing only moderately defined mode. Sample H, taken in October, includes the juvenile migration; mode is in 35 class; curve is leptokurtic; dispersion is small ($\sigma_{LS} = 4 \cdot 72$): note presence for first time of 35 LT class (3 %). **LS** min. for H is 33·5, *i.e.*, within 2·4 of the absolute min. for **TT** material, met with in Series 84, collected in Beattie's Creek, near mouth of Forth River, on 31st August, 1935, and almost certainly representing the same population sampled near the sea at the beginning of the long inland migration needed to bring fish from coastal waters to such a locality as Punchbowl Creek.

It may be noted that in this year the juvenile migration of *G.* (*G.*) *attenuatus* was accompanied by a migration of young *G.* (*G.*) *truttaceous*, 18 specimens of which, of **LS** 41·2–57·7, $\bar{x}$ 45·3, σ 3·29, accompany

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[1] The date of arrival probably varies slightly in different years, being, for instance, liable to delay, extending perhaps over some days, when unusual freshes occur in the river.

[2] In general all immigrating post larvae appear in the Creek suddenly, apparently arriving more or less in what is virtually a single wave of invasion. Note, however, in sample W, specified above, an *LS* min. of 43·1, representing a single stray individual (next smallest specimen has *LS* 57·5) whose arrival has preceded by some days that of the main invasion recorded in sample X.

Series 89. In sample H also 33 young *G.* (*G.*) *attenuatus* were accompanied by 18 of *G.* (*G.*) *truttaceus* of **LS** 42·0 – 75.5, $\bar{x}$ 54.8, σ 8.10. Similarly, 43 specimens in sample M were accompanied by 4 *G.* (*G.*) *truttaceus* of **LS** 45·6 – 51·6, x 48·0, σ 2·23.

In 1936 the vernal immigration occurred between 4th and 10th October—see graphs L, M. Sample M, Series 115, clearly comprises three age-classes: (*a*) Nos. 1–39, young fish, just migrating; treated as a separate section, these have, as regards **LS**, min. 34·4, max. 42·3, $\bar{x}$ 39·5, σ 1·43; (*b*) Nos. 41–43, about one year old, having, as regards **LS**, min. 65·1, max. 65·6, $\bar{x}$ 65·3, σ 0·21; (*c*) No. 43; one individual of **LS** 90·1, three or four years old. The vernal immigration in 1937 is shown in sample X, taken on 6th October.

This is a typical sample for this month of the year. With $h = 1$, **LS** distribution is: $(f_{37\cdot5}) - (f_{49\cdot5})$ inclusive = 1, 3, 5, 6, 5, 9, 6, respectively; with thereafter one entry in each of the following classes: 55·5, 58·5, 61·5, 62·5, 64·5, 65·5, 67·5, 73·5, 75·5, and three entries in 60·5 class. Note density, with roughly symmetrical distribution, round 42·5 class (mode), with hiatus between 49·5 and 55·5 classes, the first 35 specimens being immediately post-larval, and the 55·5 representative a small one-year individual. Specimens (35) of classes 37·5–49·5, inclusive, have, as regards **LS**, min. 37·8, max. 49·8, $\bar{x}$ 42·4, Md 41·4, σ 2·63.

Sample A, 25th November, 1934, shows migrating population about one month after arrival, and corresponds approximately with sample N, taken approximately two years later: note that A and N differ from I, of virtually the same date in 1935, in having the LS mode advanced into 45 class, perhaps indicating less rapid growth in 1935.

A leptokurtic curve in D, with well-defined mode in 45 **LS** class, and a prominent mode in 35 **LS** class in R, would seem to indicate the occurrence of a second definite juvenile immigration in February or March.

It is just possible a third migratory movement inland occurs about June—compare T_p and U_p.

A comparison of the pairs of samples (P—U) taken on the same dates in the *Larnoo* and Reserve Sections suggests the likelihood of intra-creek movements of some importance taking place at times.

Turning next to the question of emigration, we find individuals of **LS** classes $>$ 65 are absent from all samples taken in May, June, July, and from two-thirds of samples taken in February, April, November, December. Though such negative evidence cannot, of course, be relied upon, it seems clear from other considerations (*e.g.*, observations on spawning, to be noted in a future contribution) that sexually mature fish normally emigrate from creeks and headwaters of rivers, descending to brackish or salt water to spawn, about April, and are absent till about June or July. It is not unlikely that a second emigration takes place about midsummer.

The migrations of *G.* (*G.*) *attenuatus* in New Zealand have been discussed by various authors. Hutton (1872, p. 60) was apparently the first to record its catadromous habit. Clarke (1899) observes it 'periodically descends to the sea in January, February, and March, where it spawns, returning in March, April, and May,' and adds 'the young begin to appear in the rivers sometimes as early as the end of June, but they definitely commence to arrive in August, the shoals increasing in size and number in September and October'. Best (1903) has given the Maori version of the movements of the *Inanga*, which speaks of three seaward migrations. The observations of these writers and others have been reviewed by Phillipps (1919), who concluded (p. 213): (*a*) 'it migrates from the streams and rivers to the sea between some date after midsummer until after autumn'; (*b*) 'whether three separate migrations can be distinguished or not remains yet to be proved'; (*c*) 'towards the end of winter the parent fish, which have spawned in the sea, return to fresh water'; (*d*) 'the young appear off the coasts in the early spring months . . .' and 'enter the rivers and streams around the coast until about the end of November'.

Growth. General trend of growth is well illustrated by, and may be examined in, samples A, B, C (Fig. 7), collected on successive months.

Fig. A represents a pure sample of a fairly juvenile population that has recently entered the creek: this stage is later than H, M, &c., and is still compact and of low $\bar{x}_{LS}$. Dispersion small; material wholly comprised in 35, 45, **LS** classes (**LS** extreme variates 36·1, 47·0; σ_{LS} 2·71 (minimum value of all samples is 24·8 in U_L below; while σ_{LS} of segregated juvenile population—39 individuals—of M is 1·43).

With $h = 1$, **LS** distribution is virtually symmetrical, $S_k = -0{\cdot}22$. Sample is unusual in having $\mathrm{Md}_{LS} > \bar{x}_{LS}$. Data afforded by samples A-X, and *à fortiori*, that afforded by pooled NPC and TT material, suggest degree of positive skewness is a direct function of length of fish. (f_{LT}) for classes 35 - 95 = 0, 16, 5, 0, 0, 0, 0.

Sample B shows (slight) increase in **LS**, as compared with A, indicated in **LS** polygon by reduction (24-22 %) in (f_{35}), and increase (0-9 %) in (f_{55}), with concomitant reduction (76-68 %) in frequency of modal class (45). Increase in $\bar{x}_{LS}$ (here 43·8) is 1·4.

Less compact sample than A ; **LS** extreme variates 36·5, 57·8 ; σ_{LS} increased to 5·43 (excluding three specimens of 55 class, $\sigma_{LS} = 2\cdot7$ as in A) ; V_{LS} 12·4 %. Slight negative asymmetry of A here becomes positive ; $S_k = 0\cdot39$.

$(f_{LT}) = 0, 19, 10, 3, 0, 0, 0$. Thus, in **LT** polygon, (f_{55}) has increased to 31 % or > ½ modal frequency (59 %), as against < ⅓ modal frequency in A ; while (f_{65}), unrepresented in A, now accounts for 9 % of sample.

In sample C positive lateral displacement of centre of gravity of polygon, indicative of general increase in length, continues. For **LS**, (f_{35}) has further decreased (to 6 %), now being < ⅓ that in B ; while (f_{55}) has increased (to 34 %), being > ⅗ of modal frequency, as against < 1/7 in B, zero in A. Modal class (45) has dropped to 54 %. $\bar{x}_{LS} = 48\cdot7$, or 4·9 in excess of that of B : more significantly for comparison, by exclusion of 75 and 85 classes, $\bar{x}_{LS} = 46\cdot6$, an increase of 2·8 over B.

Dispersion continues to increase, σ_{LS} now 8·10 (or, making C strictly comparable with B, by exclusion of 5 individuals of **LS** > 60, $\sigma = 5\cdot44$). **LS** extreme variates 38·0, 81·9 : note successive slight increase in min. **LS** in A, B, C (36·1, 36·5, 38·0)—max. **LS** (though here also exhibiting progressive increase) obviously not a similar criterion, in view of possible adventitious inclusion (as in present sample) of specimens referable to population of different Creek-age. V_{LS} 17·3 % : coefficients of variability of A, B, C, thus approximately 1 : 2 : 3. Asymmetry positive, $S_k = 0\cdot33$. $(f_{LT}) = 0, 29, 32, 20, 1, 2, 1$. In **LT** polygon, mode for first time enters 55 class—$(f_{55}) = 36\cdot5$ %, slightly exceeding (f_{45}), which = 33 % : $(f_{65}) = 26$ %, *i.e.*, nearly thrice that in B.

The progressive increase in amount of dispersion is strikingly shown by increased length of portion of x-axis included in polygon. Excluding entries of **LS** > 65, and of **LT** > 75 (clearly referable to population of previous season, or seasons ; hence for present purposes adventitious), we find in A, B, C the **LS** polygon embraces successively 2, 3, 4 abscissal units, and the **LT** polygon 3, 4, 5 units (here continuation of graph to zero abscissal value at both ends adds in each case one unit to number of units found in corresponding **LS** polygon).

Again in D, E, F, **LS** mode of D, which is in 45 class, advances to 55 class in E, and reaches a higher value in that class in F : H, I, J exhibit successive decrease (60·8, 47·2, 45·7) in (f_{35}), *i.e.*, **LS** modal class : **LS** mode of M (35) advances to next class in N : R, S, T show successive decrease in (f_{35}), which is **LS** modal class in R ; &c.

As regards rate of growth, it is to be noted that $\bar{x}_{LS}$ of E exceeds $\bar{x}_{LS}$ of A, C by 13·1, 6·8 respectively. On evidence afforded by these means, daily rate of growth during 42 days between A and C is 0·15 ; during 63 days between C and E 0·11 ; during 105 days between A and E 0·13.

It would appear that in Punchbowl Creek, under normal conditions, the relationship of **LS** to Creek-age is somewhat as follows. Great majority of immigrating juvenile population arriving about October have **LS** 35-45, with $\bar{x}_{LS}$ approximately 40. By the end of the first summer the dominant **LS** is about 60 ± 5. During the winter, growth is virtually suspended (note winter-intervals F-G, S-V in Fig. 8): three individuals (Series 141, 142, Punchbowl Creek, 10.9.37; not included in PC material) taken at the end of the 1937 winter have **LS** 56·0, 59·7, 69·8, $\bar{x}$ 61·8. In their second year of Creek-age, these fish normally enter the 70-80 **LS** class; while specimens of **LS** > 80 are probably in most cases in at least their third season. Young fish invading the Creek near the end of summer, in February or March, enter on their first spring in the Creek with **LS** < 50.

While the investigation of migration and growth by the segregation of material into length-classes, as above, is more effective and reliable than by the consideration of mean-length graphs, in which the chance inclusion in, or exclusion from, the material of a few individuals of large **LS** exercises a marked influence, nevertheless, in the present instance, owing to the numerical dominance of small individuals in samples taken at peak-periods of juvenile immigration, the $\bar{x}_{LS}$ graph has a definite value in summarizing the results of collection over about three years, and also, to some extent, in corroborating the results arrived at in the preceding analysis. The $\bar{x}_{LS}$ graph is shown in Fig. 8: the occasional occurrence of successive intervals greater than one month is attributable to unfavourable conditions for collection of samples (*e.g.*, drying-up of Creek in December, 1935).

Attention has already been called to the fact that in A, B, C dispersion increases with increased **LS**. As greater Creek-age provides occasion for greater individual variation in size, σ_{LS} is in general an index of $\bar{x}_{LS}$. The dispersion graph is shown side by side with mean-length graph in Fig. 8. It is seen the graphs tend to follow the same general course.

Features of special interest and apparent anomalies in Fig. 8 include: (*a*) troughs α_1 - α_4 indicating vernal juvenile immigrations; (*b*) troughs β_1 (β_2 not recorded), β_3 (the latter exhibited by R_R only, the locations of the co-ordinates of which for $\bar{x}_{LS}$ and σ_{LS} are shown by arrows leading from the general graphs), showing autumn juvenile immigration; (*c*) almost horizontal line for $\bar{x}_{LS}$ during winter months; (*d*) apparent anomaly of peak of σ_{LS} at R, due to pooling of R_L and R_P (*cf.* Fig. 7); (*e*) low values of σ_{LS} during 1937 winter (*e.g.*, T, U), accounted for by combined effects of March juvenile immigration and winter spawning emigration.

VARIATION OF PROPORTIONS WITH GROWTH

(*a*) *Material.* Material measured, comprising 300 individuals, is specified as regards series (hence, also locality and date), and number of individuals in length-classes (with $h = 10$) in Table III. It has not been found practicable to make length-classes numerically equal; and it is probable that in the growth-curves discussed below data lying within the limits $35 \lessdot \text{LS} \underline{\lessdot} 105$ (which approximately corresponds with Creek-range) are statistically more significant than data relating to classes with LS $\gtrdot$ 105 (note, in passing, omission in Table III of classes 145, 155, 165).

TABLE III

G. (G.) attenuatus (Jenyns)

SPECIFICATION OF SERIES FOR VARIATION OF PROPORTIONS WITH GROWTH

Series No.	No. of Individuals Length-Classes of LS													
	35	45	55	65	75	85	95	105	115	125	135	175	185	Total
13	—	—	1	—	4	2	4	3	2	—	—	—	—	16
14	—	—	—	1	—	4	5	—	—	—	—	—	—	10
15	—	—	1	—	2	2	2	2	—	—	—	—	—	9
45	6	15	—	—	—	—	—	—	—	—	—	—	—	21
58	—	—	—	—	—	—	—	—	—	—	—	1	1	2
61	6	27	6	1	3	—	—	—	—	—	—	—	—	43
70	1	13	17	13	3	1	—	—	—	—	—	—	—	48
73	2	10	12	2	—	3	—	—	—	—	—	—	—	29
74	—	13	9	2	1	—	—	—	—	—	—	—	—	25
76	—	—	—	—	—	—	1	2	2	1	—	—	—	6
81	—	4	3	1	3	—	—	—	—	—	—	—	—	11
86	—	3	4	1	1	—	—	—	—	—	—	—	—	9
106	—	—	14	4	2	—	—	—	—	—	—	—	—	20
110	—	—	—	—	5	2	7	11	7	7	1	—	—	40
114	—	—	3	4	3	1	—	—	—	—	—	—	—	11
Total	15	85	70	29	27	15	19	18	11	8	1	1	1	300

(*b*) *Dimensions.* The following nine dimensions have been determined for these 300 specimens (Table IV): standard length, length to origin of dorsal fin, length to origin of pelvic fin, depth of body (maximum), length of caudal peduncle, depth of caudal peduncle (minimum), length of caudal fin, length of head, horizontal diameter of eye. Implicit in these dimensions are also total length (LS + length of caudal), length to origin of anal fin (identical, in this species, with length to origin of dorsal), base of anal fin (LS − [length to anal + length of caudal peduncle]), approximate length of trunk and of tail (since length to dorsal = length to anal = approximate length to vent), &c.

TABLE IV.

G. (G.) attenuatus (Jenyns)

DIMENSIONS OF 300 INDIVIDUALS.

Dimension		35	45	55	65	75	85	95	105	115	125	135	175	185
Standard Length (LS)	Min.	36·0	40·0	50·1	60·3	70·0	80·5	90·8	100·8	110·3	120·1	133·8	172·0	185·0
	Max.	39·9	49·9	59·9	68·5	79·9	89·9	99·9	114·5	119·9	126·5	133·8	172·0	185·0
	Md.	39·0	45·0	54·3	63·0	72·1	84·6	95·8	106·0	113·0	123·6	133·8	172·0	185·0
	$\bar{x}$	38·9	45·2	54·3	63·6	73·6	85·0	95·5	105·2	113·4	123·7	133·8	172·0	185·0
	σ	1·3	2·9	2·7	2·4	2·8	3·1	2·6	4·0	2·7	1·9	0·0	0·0	0·0
Length to Dorsal Fin	Min.	26·1	28·5	35·9	44·6	52·0	61·5	70·0	75·0	88·0	93·6	116·6	136·0	139·0
	Max.	31·5	39·0	48·5	52·0	60·0	68·2	75·5	88·0	93·0	98·2	116·6	136·0	139·0
	Md.	28·7	33·0	40·5	47·9	55·0	63·5	72·6	80·2	86·0	95·8	116·6	136·0	139·0
	$\bar{x}$	28·7	33·5	41·0	47·8	56·8	62·9	72·6	81·0	86·6	95·7	116·6	136·0	139·0
	σ	1·3	2·5	2·6	2·1	2·7	3·1	1·8	2·9	2·6	1·6	0·0	0·0	0·0
Length to Pelvic Fin	Min.	16·5	18·0	21·0	28·2	31·5	38·0	43·5	45·0	50·7	56·2	64·5	82·0	90·0
	Max.	19·5	24·9	29·0	34·0	39·6	44·0	48·5	54·0	56·0	63·0	64·5	82·0	90·0
	Md.	18·0	21·0	26·0	30·0	35·5	40·6	46·0	51·0	54·0	59·2	64·5	82·0	90·0
	$\bar{x}$	18·1	21·2	26·1	30·4	35·3	40·8	45·9	50·2	53·9	59·4	64·5	82·0	90·0
	σ	0·8	1·5	1·7	1·3	1·8	1·6	1·5	2·8	1·5	2·0	0·0	0·0	0·0
Depth of Body	Min.	3·1	2·2	5·0	7·0	8·0	10·0	10·6	12·8	13·1	16·0	21·5	30·0	36·0
	Max.	4·1	6·8	9·0	10·0	12·1	14·5	18·9	17·8	18·6	20·5	21·5	30·0	36·0
	Md.	4·0	4·8	6·5	8·2	10·1	12·0	13·8	15·5	15·5	19·3	21·5	30·0	36·0
	$\bar{x}$	4·0	5·1	6·7	8·4	9·9	12·3	13·8	15·6	16·0	19·2	21·5	30·0	36·0
	σ	0·3	1·2	0·7	0·9	0·9	1·2	1·8	1·2	1·8	1·4	0·0	0·0	0·0
Length of Caudal Peduncle	Min.	4·0	4·0	5·0	6·0	6·8	6·6	8·6	9·0	10·3	11·5	15·1	20·0	26·0
	Max.	5·5	6·1	7·5	7·6	9·1	9·5	11·9	11·6	13·2	14·5	15·1	20·0	26·0
	Md.	4·8	5·1	6·2	6·6	7·7	8·5	9·4	10·5	11·1	12·6	15·1	20·0	26·0
	$\bar{x}$	4·7	5·1	6·2	6·8	7·9	8·5	9·6	10·5	11·1	12·9	15·1	20·0	26·0
		0·5	0·4	0·5	0·5	0·6	0·8	0·8	0·5	0·8	0·9	0·0	0·0	0·0

TABLE IV—*continued*

G. (G.) attenuatus (Jenyns)

DIMENSIONS OF 300 INDIVIDUALS

Dimension		35	45	55	65	75	85	95	105	115	125	135	175	185
Depth of Caudal Peduncle	**Min.**	1·5	1·8	2·8	2·8	3·9	4·5	5·2	5·5	5·8	6·6	8·3	13·5	15·0
	Max.	4·0	3·4	4·0	4·5	5·6	5·8	6·5	8·6	8·0	8·6	8·3	13·5	15·0
	Md.	2·1	2·5	3·1	3·6	4·4	5·0	5·6	6·3	6·7	7·5	8·3	13·5	15·0
	$\bar{x}$	2·2	2·4	3·1	3·7	4·5	5·1	5·8	6·5	6·8	7·5	8·3	13·5	15·0
	σ	0·7	0·3	0·4	0·5	0·4	0·3	0·4	0·7	0·5	0·6	0·0	0·0	0·0
Length of Caudal Fin	**Min.**	4·5	4·2	5·3	6·1	8·9	8·4	10·2	12·7	14·0	16·5	17·7	20·0	22·0
	Max.	6·5	8·8	12·0	10·5	11·5	12·8	15·5	16·5	17·5	21·0	17·7	20·0	22·0
	Md.	5·5	6·5	8·0	9·0	10·2	11·5	13·4	15·0	15·5	17·3	17·7	20·0	22·0
	$\bar{x}$	5·6	6·5	7·9	9·0	10·5	11·5	13·3	14·7	15·7	17·9	17·7	20·0	22·0
	σ	0·5	0·9	0·9	0·8	0·6	1·0	1·2	0·3	1·1	1·4	0·0	0·0	0·0
Head	**Min.**	6·4	6·0	8·2	10·2	11·8	12·5	15·3	16·3	17·5	18·0	21·0	29·0	31·0
	Max.	8·0	10·0	11·5	13·0	18·3	15·3	17·5	19·2	21·1	21·0	21·0	29·0	31·0
	Md.	7·0	8·0	9·7	11·2	12·9	14·1	16·0	17·8	18·5	19·5	21·0	29·0	31·0
	$\bar{x}$	7·1	8·1	9·8	11·3	13·5	14·1	16·2	17·8	18·8	19·4	21·0	29·0	31·0
	σ	0·5	0·7	0·7	0·8	1·4	0·7	0·7	1·6	1·0	0·7	0·0	0·0	0·0
Eye	**Min.**	2·0	2·0	2·1	2·6	2·6	3·0	3·5	3·7	3·9	4·1	4·1	5·5	6·0
	Max.	2·5	2·9	3·1	3·4	3·9	3·8	4·5	4·5	5·0	4·7	4·1	5·5	6·0
	Md.	2·1	2·5	2·8	3·0	3·3	3·5	3·9	4·1	4·3	4·4	4·1	5·5	6·0
	$\bar{x}$	2·2	2·5	2·7	3·0	3·3	3·4	3·9	4·2	4·3	4·4	4·1	5·5	6·0
	σ	0·2	0·2	0·2	0·2	0·3	0·2	0·2	0·2	0·3	0·2	0·0	0·0	0·0
No. in Class		15	85	70	29	27	15	19	18	11	8	1	1	1

GROWTH–CURVES

Growth-curves with length to dorsal, length to pelvic, depth of body, length of caudal peduncle, depth of caudal peduncle, head, eye, length of caudal, plotted as ordinate against actual $\bar{x}_{LS}$ (not mid-points of LS class) of classes 35, 45 .... 135, 175, 185 as abscissa are shown in Fig. 9, A–H: while eye in head and depth of caudal peduncle in its length are shown in Fig. 11, A, C, and these two body-ratios are also plotted against $\bar{x}_{LS}$ as abscissa in Fig. 9, I, J.

It is found that most of these curves yield approximations to straight lines when treated logarithmically: these are replotted in Fig. 10, A–J, the ordinate being the logarithm of mean value of dimension or ratio, and the abscissa log $\bar{x}_{LS}$. Logarithmic equivalents of Fig. 11, A, C are shown in Fig. 11, B, D.

The use of a double logarithmic grid is of considerable interest in showing that some regions of the body—*e.g.*, length to dorsal, length of caudal peduncle, depth of caudal peduncle—show increase in absolute size with absolute size (measured by **LS**) of the fish as a whole (heterogony). The results of Hecht (1916), quoted by Huxley (1932, p. 38), show long-continued isogony (organ, or region, growing at same rate as organism) in all measured dimensions in fish; but Huxley points out that the work of Keys (1928), who finds that in herrings, sardines, and *Fundulus* the weight increases faster than the cube of length, which implies form-change, and results obtained by Hickling (1930) for *Acanthias vulgaris* Risso and by Shaw (1931) for *Paracheilognathus* indicate that Hecht's assumption of form-constancy in teleosts is not strictly true. The present observations would seem clearly to indicate the general occurrence in *G.* (*G.*) *attenuatus* of simple heterogonic growth, usually not far removed from isogony, possibly also of 'non-simple' (*e.g.*, exponential) heterogonic functions—results of immediate and practical value in the systematics, and of interesting implications in the general biology, of the group.

(*a*) ***Length to Dorsal on* LS.** Direct plotting of means in Fig. 9, A; logarithmic plotting in Fig. 10, A. Length to dorsal is positively heterogonic [increasing in relative size with growth (Huxley, 1932, p. 17)]. Applying Huxley's simple heterogony formula, $y = bx^{k}$[1] [x

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[1] This use of k implies that the ratio of relative growth-rate (= rate of growth per unit weight, *i.e.*, actual absolute growth-rate at any instant divided by actual size at that instant) of organ to relative growth-rate of body remains constant (through range over which formula holds), the ratio itself being denoted by the value of k. This is at once seen by plotting log y against log x. In unit time increase in log y is k times increase in log x,

$$i.e., \frac{d}{dt} \log y = k \frac{d}{dt} \log x$$

is magnitude of organism, *i.e.*, here = LS; b is a constant, the fractional coefficient, which merely denotes the value of y when $x = 1$, and is for our present purpose of no particular biological significance; k is a constant, the growth-coefficient of the organ, denoting a constant differential growth-rate], we have for the straight line passing through the points for the 35 and 125 classes, which affords a good approximation to the general linearity of the graph, y $0{\cdot}63\,x^{1\cdot04}$. Growth-coefficient is thus 1·01.

(*b*) *Length to Pelvic on* **LS.** Direct plotting in Fig. 9, B; logarithmic plotting in Fig. 10, B. The ratio is nearly isogonic. Its equation in the form y $ax + b$, which Scammon employs extensively in his

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$$\text{or } \frac{dy}{dt}\Big/ y = k\frac{dx}{dt}\Big/ x$$

The prime merit of Huxley's formula, as compared with certain arbitrary formulae employed by other investigators—*e.g.*, $y = mx + c$, which holds true only for isogonic growth, isogony being merely a particular case of heterogony, as the circle is a special case of the ellipse; and which affords a useful approximation only while the value of the growth-coefficient does not markedly depart from unity—resides in the fact that it may be directly deduced (Huxley, 1932, p. 6) from certain fundamental principles of growth in general

Three fundamental facts concerning growth are: (1) it is a process of self-multiplication of living substance, *i.e.*, rate of growth of an organism growing equally in all its parts is at any moment proportional to size of organism, (2) rate of self-multiplication decreases with increasing age (size), (3) rate is influenced by external environment Now (2) and (3) affect all parts of body equally, hence we may assume the growth-rate of a given organ is proportional simultaneously, (*a*) to a specific constant characteristic of organ, (*b*) to size of organ at any instant, (*c*) to a general factor dependent on age and environment, which is the same for all parts of the body.

Hence when y stands for size of organ, and x for size of rest of body, while α, β are specific constants for rest of body, organ, respectively, and G measures general conditions of growth as affected by age and environment, we have

$$\frac{dx}{dt} = \alpha\, x\mathrm{G} \text{ and } \frac{dy}{dt} = \beta\, y\mathrm{G},$$

$$\text{hence } \frac{dy}{dx} = \frac{\beta y}{\alpha x},$$

$$\text{or} \quad \log y = \frac{\beta}{\alpha} \log x + \log b \quad (b \text{ being a constant})$$

$$i.e., \quad y = bx^{\frac{\beta}{\alpha}}$$

in which $\frac{\beta}{\alpha}$ is a constant, denoted by k, the growth-coefficient, or ratio of the specific components of growth-rates of y and x respectively.

Since the simple heterogony formula can be written $\log y = \log b + k \log x$, magnitudes obeying the formula fall along straight lines when plotted on a double-logarithmic grid.

important work on the growth of the human foetus (references in Scammon and Calkins, 1929), is $y = 0{\cdot}49x - 1{\cdot}06$. The graph very nearly passes through the origin, and accordingly the length to pelvic-LS ratio is approximately constant, its value from the equation above being 0·49, or, calculated direct from mean of length to pelvic and $\bar{x}_{LS}$ for 300 specimens, 0·478.

The location of pelvic-root relative to tip of snout and hypural joint has customarily been invested with great taxonomic significance among the Galaxiidae, and is one of the characters employed by Regan (1906, p. 369) in differentiating between South American, New Zealand, and Australian races of *G.* (*G.*) *attenuatus* (Jenyns). These observations tend to confirm its value as a diagnostic character, used in this way, in the present species. A few general observations, which need, however, to be substantiated by more extensive measurements, suggest the ratio may not have equal diagnostic significance in all species of the genus—*cf.* remarks (Scott, 1936, p. 100) on *G.* (*G.*) *parkeri* Scott.

With logarithmic plotting (Fig. 10, B), $y = 0{\cdot}421\ x^{1{\cdot}027}$.

(*c*) *Depth of Body on* **LS**. Direct plotting in Fig. 9, C: logarithmic plotting in Fig. 10, C. Growth is heterogonic. Best straight line gives $y = 0{\cdot}022x^{1{\cdot}414}$, the growth coefficient thus being fairly high (1·414). These results are in marked contrast to those of Hecht for the teleost *Orthopristis chrysopterus*, his graph of maximum depth on total length (range of latter 4-24 cm.) showing with direct plotting a straight line, the equation of which, determined from his figure, is $y = 0{\cdot}25x$.

(*d*) *Length of Caudal Peduncle on* **LS**. Direct plotting in Fig. 9, D; logarithmic plotting in Fig. 10, D. Direct plotting of means of length of caudal peduncle against means of LS gives a markedly curvilinear graph, and plotting of logarithms of means still leaves graph clearly curved, this ratio thus differing from those hitherto considered.

The results could be interpreted by regarding Fig. 10, D as consisting of two sections, the first (LS 38·93—113·39) having a growth-coefficient of about 0·80, and the second (LS 113·39—185·0) a growth-coefficient of about 1·73. Such a state of affairs, in which a constant differential growth-rate is maintained during part of the life of an organism, being preceded or succeeded at a given period (usually at a definitive phase of its history, *e.g.*, onset of heterogony of large chela at first or second instar of post-larval life in the crab *Uca pugnax*; isogony followed by heterogony, probably at sexual maturity, in chelae of the spider crab *Maia squinado*, &c.) by isogony or by heterogony of a different magnitude, is by no means unknown. An inspection of

Figs. 9, 10 reveals, indeed, in more than half the curves illustrated a more or less marked indication of a change of slope occurring at about LS 125, which is not improbably the approximate length of normal maturity.

An alternative method of attack is indicated by the suggestion in Fig. 9, D of a curve of the exponential family. The equation $y = b\,e^{kx}$ appears to provide the best fit. Exponential plotting yields a fair approach to linearity, the graph, though somewhat irregular, showing no marked general predominance of positive or negative ordinal values. Best straight line is $y = 1\cdot109e^{-2\cdot26x}$.

(*e*) *Depth of Caudal Peduncle on* **LS.** Direct plotting in Fig. 9, E; logarithmic plotting in Fig. 10, E. Through approximate Creek-range (first 8 x-points) double logarithmic plotting gives a remarkably close approximation to a straight line, indicating simple heterogony, with growth-coefficient $k = 1\cdot117$ ($y = 0\cdot036\,x^{1\cdot117}$). The interpretation of the curve to the right of **LS** = 105·2 is doubtful.

(*f*) *Head on* **LS.** Direct plotting in Fig. 9, F; logarithmic plotting in Fig. 10, F. Best straight line for Fig. 10, F is $y = 0\cdot240\,x^{0\cdot928}$. Hence, growth is nearly isogonic, as is also evident from Fig. 9, F, the approximate equation for which is $y = 0\cdot165\,x + 0\cdot62$: graph very nearly passes through the origin; and hence head-in-**LS** is approximately constant, its value, calculated direct from the mean length of head and $\bar{x}_{LS}$ for 300 specimens, being 0·173.

(*g*) *Eye on* **LS.** Direct plotting in Fig. 9, G; logarithmic plotting in Fig. 10, G. Graph shows a point of inflexion in 85 class; probably not significant. Simple heterogony equation is $y = 0\cdot288\,x^{0\cdot564}$.

(*h*) *Length of Caudal on* **LS.** Direct plotting in Fig. 9, H; logarithmic plotting in Fig. 10, H. Over normal range of **LS**, plotting on a double logarithmic grid yields a good approach to a straight line, the approximate equation of which is $y = 0\cdot170\,x^{0\cdot956}$.

(*i*) *Eye on Head.* Direct plotting in Fig. 11, A; logarithmic plotting in Fig. 11, B. From direct plotting, which yields a very fair degree of linearity, we have $y = 0\cdot187\,x + 0\cdot833$. Double logarithmic plotting gives a rather markedly curvilinear graph with a k-value of about 1·6.

The ratio eye-in-head, which is a recognized diagnostic criterion among the Galaxiidae, is plotted against LS directly in Fig. 9, 1; on a double logarithmic grid in Fig. 10, 1.

(*j*) *Depth of Caudal Peduncle on Length of Caudal Peduncle.* Direct plotting in Fig. 11, C; logarithmic plotting in Fig. 11, D. Note the suggestion of the existence of two cycles of growth, the first ending, the second beginning, at the 125 LS-class. For the graph as a whole, k is approximately 1·0.

Results of plotting the ratio depth-of-caudal-peduncle-in-its-length against LS directly, logarithmically, are shown in Fig. 9, J, Fig. 10, J, respectively. In both cases the curves are concave—a fact not very obvious in Fig. 9, J: on replotting with the ordinate scale multiplied, say, tenfold, the greater part of the curve superficially suggests a catenary—and have a general negative slope. Though the ratio depth-of-caudal-peduncle-in-its-length is customarily noted in specific diagnosis in the genus *Galaxias*, it is, in general, not a very significant character, inasmuch as, in the first place, its value varies, as here demonstrated, with length-of-fish (Regan's revision of the family records a variation of 50%, or more, in the value of the ratio in the case of some species), and, in the second place, its mean value is in few species markedly different from its mean values in allied forms.

GROWTH-GRADIENTS: AXIAL GROWTH-POTENTIAL

Huxley (1932), who has extended and generalized the conceptions of regional differential growth formulated by D'Arcy Thompson (1917) and others, and has in part subjected the problems involved to quantitative analysis, has plotted growth-coefficients of successive regions of an organ as ordinates at equal arbitrary intervals along the x-axis, and thus obtained a curve representing the distribution along the organ of *growth-potential*. Such a curve is a graphic representation of a *growth-gradient* within the organ, the inclination of the curve to the horizontal representing the steepness of the gradient, or in other words the difference in absolute growth-potential between the two ends of the gradient (as measured by growth-coefficients, which for the present purpose afford the only comparable standard for measuring intensity of growth-potential in a number of different regions) in relation to length of gradient—*i.e.*, relative length of organ (Huxley, 1932, pp. 80-81).[1]

The method obviously may be extended to cover the graphing of growth-gradients along the axial line of an organism to show the general distribution of growth-potential in the animal as a whole; and some work on teleosts along these lines has been done by Huxley (1931), Ford (1930, 1931), and others.

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[1] Some formal difficulties are discussed by Huxley (1932, p. 81). Note, for instance, that if y be value (say, linear measurement) of organ as a whole, and if y_1, y_2 . . . yn be the corresponding values of its constituent regions, then if $y = bx^k$ be a correct expression for the organ as a whole, then $y_1 = b_1x^{k_1}$, $y_2 = b_2x^{k_2}$, and so on, cannot be accurate expressions for the separate parts (or *vice versa*), since the sum of the several expressions for the parts will not exactly fit the expression for the whole: nevertheless, within certain limits of the value of k, the discrepancy will be only slight, and the use as above of growth-coefficients as standards of growth-intensity gives a close approximation to the truth.

In the present case, we may proceed caudad from the tip of the snout, distinguishing the following successive regions: (α) tip of snout to posterior margin of operculum (= length of head); (β) thence to insertion of root of pelvics (= head − pelvic interspace); (γ) thence to origin of dorsal (= pelvic − dorsal interspace, identical in *G.* (*G.*) *attenuatus* with pelvic − anal interspace); (δ) thence to end of base of anal (= anal base; calculated below from [LS − length of caudal peduncle] − length to origin of dorsal); (ε) thence to hypural joint (= length of caudal peduncle); (ζ) thence to posterior tip of outspread caudal fin (= length of caudal).

In the following analysis of the axial growth-potential we shall confine our investigations to the first eight length-classes in Table IV, covering LS 38·93 − 105·21 (*i.e.*, approximately Creek-range) and comprising 278 specimens.

Calculating the values for the six regions $\alpha - \zeta$ from data in Table IV, plotting results on a double logarithmic grid, and finding for the best straight line in each case its equation in the form of the simple heterogony formula, $y = bx^k$, we get the following growth-coefficients: $k_{\alpha} = 0{\cdot}95$, $k_{\beta} = 1{\cdot}09$, $k_{\gamma} = 1{\cdot}03$, $k_{\delta} = 0{\cdot}86$, $k_{\varepsilon} = 0{\cdot}75$, $k_{\zeta} = 0{\cdot}97$.

Axial growth-potential of *G.* (*G.*) *attenuatus* for LS 38·93 - 105·21 is shown in Fig. 12 (solid line).

Most important features are: (*a*) graph is a smooth curve (this appears to be a characteristic feature of growth-gradients in general, judging by cases cited by Huxley); (*b*) the highest point of the gradient, the *growth-centre*, occurs at β, sloping away for regions cephalad and caudad of the head-pelvic interspace, with a change of sign of gradient occurring at the region of the caudal fin; (*c*) regions in descending order of magnitude of their growth-coefficients are $\beta, \gamma, \zeta, \alpha, \delta, \varepsilon$; (*d*) for regions $\alpha, \beta, \gamma, \zeta$ coefficients closely approach unity, indicating that growth in these regions is nearly isogonic, the most markedly heterogonic regions being ε, followed by δ.

If we assume the end-classes (35, 105) are typical (*i.e.*, solve for each region, $y = bx^k$ for $x = 38{\cdot}93$, $x = 105{\cdot}21$), we get the distribution of growth-potential along the body-axis shown in Fig. 12 (dotted line). We find that in this particular case of the general expression of growth-gradient the sequence in descending order of magnitude of the growth-coefficients is $\beta, \gamma, \zeta, \alpha, \delta, \varepsilon$. as before, the values for γ, δ, and ε showing slight increases, that for α a slight decrease, and those for β and ζ being unchanged.

VIABILITY OUT OF WATER

It is well known that several of the Galaxiidae may survive for considerable periods out of water, a celebrated case, of course, being that of *Neochanna apoda* Günther, the type specimen of which was obtained in stiff clay 4 feet below the surface (Günther, 1867). Hall (1901) and Fletcher (1906)[1] have recorded Tasmanian Galaxiids found in damp earth. See also observations of Phillipps (1926, p. 532) on survival of *Saxilaga* (*Lixagasa*) *burrowsius* and those of Scott (1934) on *S.* (*S.*) *cleaveri* (Scott) and on *G.* (*G.*) *truttaceus* Cuvier. Some observations of survival out of water in the laboratory—the first, so far as I am aware, dealing with extra-aqueous survival of *G.* (*G.*) *attenuatus*—are recorded below.

(*a*) *Material.* Series 11, 61, 70, 73, 114, 119, comprising 154 specimens. These series are specified in Table I, except in the case of Nos. 11, 1-7 (Punchbowl Creek: not trapped, and hence not included in PC material), which series has, as regards LS, min. 45·0, max. 101·5, $\bar{x}$ 77·8, Md 82·4, 10 mm. modal class 85, 105 (each 2 cases), σ 2·09.

(*b*) *Method.* Specimens used in these investigations were taken from their vessel, drained of their surplus water by being placed for a short time in an ordinary hemispherical household strainer with large mesh, and introduced into a dry enamel bucket, where they were examined at convenient intervals, half-hourly inspections being made where practicable.

(*c*) *Behaviour.* As a rule, the fish remain quite lively for many hours, jumping at intervals 3-4 inches straight up into the air, or slithering a similar distance up the side of the bucket. Respiration is noisy, especially in the earlier stages, the clicking sound caused by the movements of the operculum, mingled with the light thud made by the descent of a leaping fish, being in the case of a large series almost continuous. An upright posture, with the ventral surface resting squarely on the bottom of the vessel, is commonly maintained, especially in the earlier stages of exposure. No. 5 of Series 70, LS 61·8 mm., had swallowed 44 mm. of an earthworm 47 mm. long prior to the beginning of the experiment: this individual survived exposure for 1·5 hours.

(*d*) *Rate of Respiration.* The initial rate of respiration, about 58 per minute, decreases to 43-46 after five hours, and to about 35 after nine hours.

(*e*) *Duration of Survival.* Maximum duration of survival out of water in trials A-F respectively = 21·25, 25·0, 11·5, 20·0, 25·5, 12·5 hours, giving crude average of 10·7, or weighted average of 8·6. Survival of 10 hours or more is recorded in 46·1 % of individuals, of

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[1] Specimens obtained at West Strahan, Tasmania, by Miss M. Lodder; dug up in damp soil remote from any water. Fletcher states Stead examined the specimens, and reported that 'with some reservation they might perhaps be referred to *Galaxias truttaceus* Cuv. & Val.'. I am inclined, however, to believe they are probably not referable to *Galaxias* Cuvier at all, but to *Saxilaga* Scott.

20 hours or more in 6·5 %. It seems fairly evident that the external conditions of the experiment largely influence the survival-duration, the most important factors probably being temperature, atmospheric humidity, and time of day (evidence suggests viability is markedly greater at night[1]); intrinsic factors are discussed below.

Data are adequately summarized in Fig. 13, in which elapsed time in hours is plotted against number of surviving individuals. The curve M (dotted line) is an approximate generalized curve, in which weighted means of ordinates of A-F (numbers of surviving individuals) are plotted at abscissal intervals of 2·5 hours. As A-F are not strictly comparable one with another, owing to variation in external conditions in the six trials, M cannot be accepted as a precise representation of the survival curve; but it is of interest as an approximate indication of the general form that the individual curves A-F are seen, on smoothing, to approach.

(*f*) *Survival-Sequence a Function of* **LS**. Arranging the specimens in the order, from first to last, in which they succumb, and allotting a number, the survival-sequence number, N_S, to them, in accordance with their position in this series, we are led to the interesting conclusion that, on the average, $N_S \propto$ **LS**.

In Fig. 14 the curves A-F exhibit **LS** plotted against N_S. In the majority of cases, despite marked individual fluctuation, the general tendency of **LS** to increase with N_S is quite evident. An attempt is made in Fig. 14 M to obtain a generalized result for A-F: the six curves have been plotted on the same abscissal interval, and the weighted means of the ordinates (**LS**) are exhibited in the present graph.

For pooled results shown in Fig. 14 M we have $\bar{x}_{\mathbf{LS}}$ for successive quarters to succumb, respectively, 50·38, 50·56, 54·90, 61·74, crude; or 42·50, 43·01, 45·88, 51·32, when weighted for size of samples. Thus approximately **LS** is an index of N_S.

(*g*) *Survival-Duration and* **LS**. Since the external conditions of the trials, which so far have not been found susceptible of precise measurement, so largely determine the duration of survival of any given series of individuals, we cannot obtain any precise quantitative expression of the relation between survival-duration and **LS** that will hold good beyond the limits of a single trial.[1] For the four successive quarters of samples A-F pooled, weighted time (total) is 19·1, 63·3, 91·7, 105·4 hours, respectively.

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[1] Trials A-F were begun at 5.22 p.m., 5.53 p.m., noon, 3.35 p.m., 5.30 p.m., 9.40 a.m., respectively. Trials C and F, begun at noon or in forenoon, give crude average period of survival 7·0 hours, or weighted average of 5·3. Trials A, B, D, E, begun in afternoon, give corresponding values of 12·5, 11·0.

(*h*) *Other Intrinsic Survival-Factors.* After the experiments had been in progress for some time, it was observed that early mortality appeared to be more common among specimens with light ground-colour than among darker individuals. A record kept for 111 individuals suggests that general intensity of ground-colour is probably a minor factor determining extra-aqueous viability; but the present data do not provide adequate grounds for a satisfactory conclusion on the matter.[2] The question of a possible connection between viability and sex has not been investigated.

(*i*) *Survival Under Natural Conditions.* It is thus seen that even under rather rigorous laboratory conditions *G.* (*G.*) *attenuatus* is capable of surviving without external water for considerable periods. It seems, therefore, not unlikely that in a state of nature this species may at times weather short periods at least of partial drought, probably in a moist or humid environment.

(*j*) *Aestivation.* Reports received from time to time suggest *G.* (*G.*) *attenuatus* may upon occasion temporarily aestivate, when the drying-up of small watercourses with such celerity as to preclude the possibility of quick migration presents it with the alternatives of doing so or perishing. So far, however, all attempts I have made personally, by digging in the beds and banks of streams subject to sudden aridity, to find specimens actually imbedded in moist soil have yielded negative results.

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[1] Assuming that LS is the only intrinsic factor for determining duration of survival (it is certainly the dominant, but probably not the sole, factor: see below), we find LS (mm.) minus a constant is approximately proportional to the sixth power of the time (hours).

[2] Specimens were classified in practice as 'light', 'medium light', 'medium dark', 'dark'. Pooling the first two categories as light, and the second two as dark, for total material examined (111 specimens), we get $N_{1-55\cdot5}$ 83·5 light, 22 dark: $N_{55\cdot5-111}$ 12·5 light, 43 dark. Treating these results as a fourfold table for relative survival-duration and relative depth of ground-colour, and calculating χ^2 directly from the formula

$$\chi^2 = \frac{(ad - bc)^2 \, (a + b + c + d)}{(a + b) \, (c + d) \, (a + c) \, (b + d)}$$

where *a*, *b*, *c*, *d* are the four quantities, we get $\chi^2 = 16\cdot37$, a result which, on entering the table for χ^2 (Fisher, 1932) with $n = 1$ (the system having one degree of freedom), is seen to be clearly opposed to the hypothesis of independence.

SUMMARY

1. Standard and total length are specified for 1415 individuals. The former, which is statistically a logarithmic function of the latter, is morphologically and experimentally the preferable criterion of length-of-fish.

2. Approximately 78% of total (89% of Punchbowl Creek) material is in first year; 8% of total (5% of Punchbowl Creek) material in second year.

3. Minimum, maximum, mean standard length of total material: 185·0, 31·1, 53·81 mm., respectively.

4. Post-larval specimens often exhibit colour-pattern (possibly a primitive family character) on caudal fin; occasionally retain vestiges of yolk-stalk, with associated vascular plexus, in individuals that have migrated 40 miles inland; normally show onset of ground-pigmentation at standard length of about 40 mm.

5. Frequency distribution of standard length has a positive skew.

6. In Punchbowl Creek there occurs an extensive juvenile influx in October, followed by a less important immigration in March, and possibly by an inland movement in July.

7. Emigration of adults takes place about April; fish returning after spawning, about July.

8. Relation of standard length to Creek-age in Punchbowl Creek: at vernal immigration about 40 mm.; at end of first summer 60±5 mm.; in second year of Creek-age 75±5 mm.; in third, or later season, > 80 mm.

9. Growth-curves of nine dimensions, based on 300 specimens, show relative growth is in general heterogonic, approximating to isogonic: length of caudal peduncle on standard length is an exponential function.

10. Graph of axial growth-potential shows growth-centre in head-pelvic interspace, whence gradient slopes away cephalad and caudad, with a change of sign in region of caudal fin.

11. Fish survive out of water up to 25·5 hours: 46% of specimens examined survived 10 hours, or more.

12. Extra-aqueous viability, as determined by duration of survival, is a direct function of standard length; perhaps, also, of pigmentation-density.

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PLATE XVIII

FIG. 1.—Map showing distribution of material (mainland of Tasmania only).

FIG. 2.—Percentile curves of standard length. Punchbowl Creek (PC), Non-Punchbowl Creek (NPC), and total Tasmanian (TT) material.

PLATE XVIII

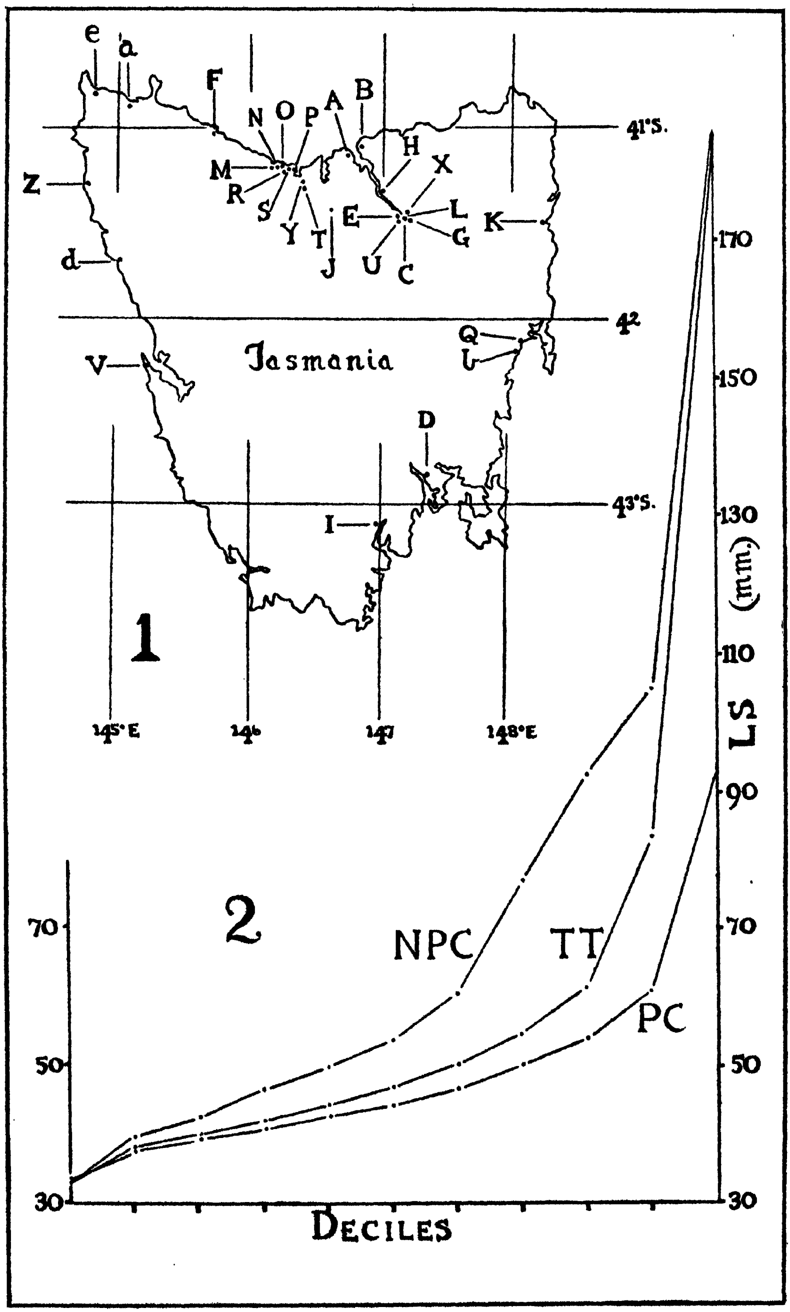

1
e
a
F
N
O
P
A
B
H
X
M
R
S
Y
T
E
L
K
G
Z
J
U
C
d
41°S.
42
Q
U
V
Jasmania
D
43°S.
I
145°E
146
147
148°E
2
NPC
TT
PC
70
50
30
170
150
130
110
90
70
50
30
LS (mm.)
DECILES

PLATE XIX

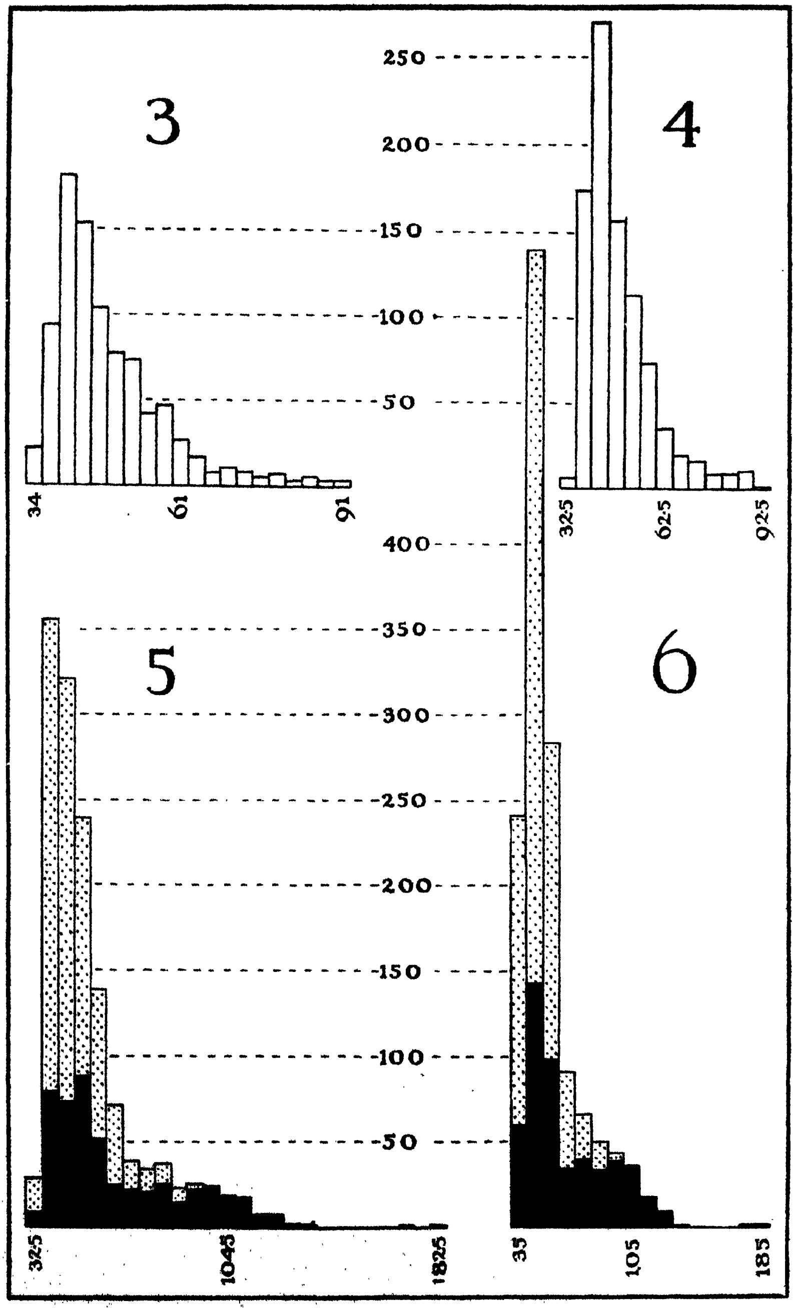
Frequency distribution of standard length.

Fig. 3.—Punchbowl Creek material. 3-mm. classes.

Fig. 4.—The same. 5-mm. classes.

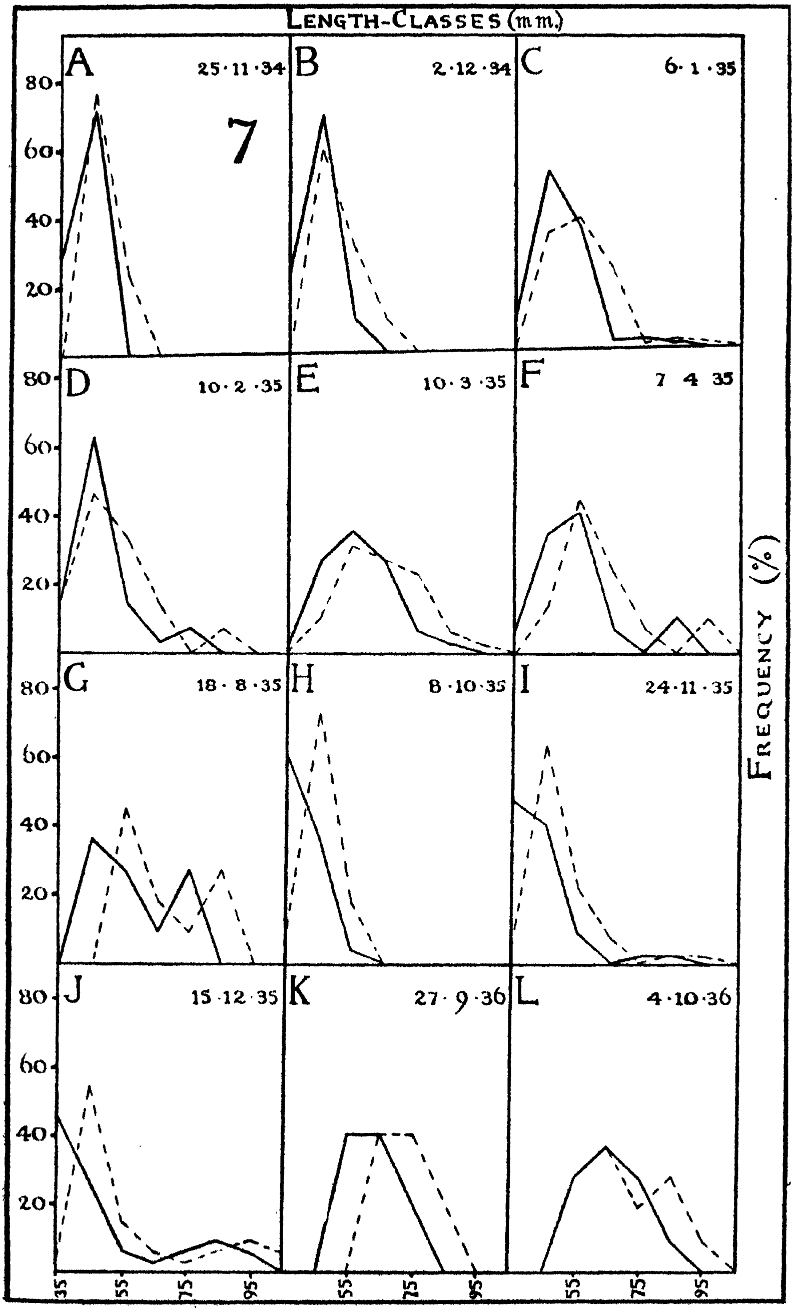
Fig. 5.—Non-Punchbowl Creek material (solid black rectangles) and total Tasmanian material (combined solid black and stippled rectangles) 6-mm. classes.

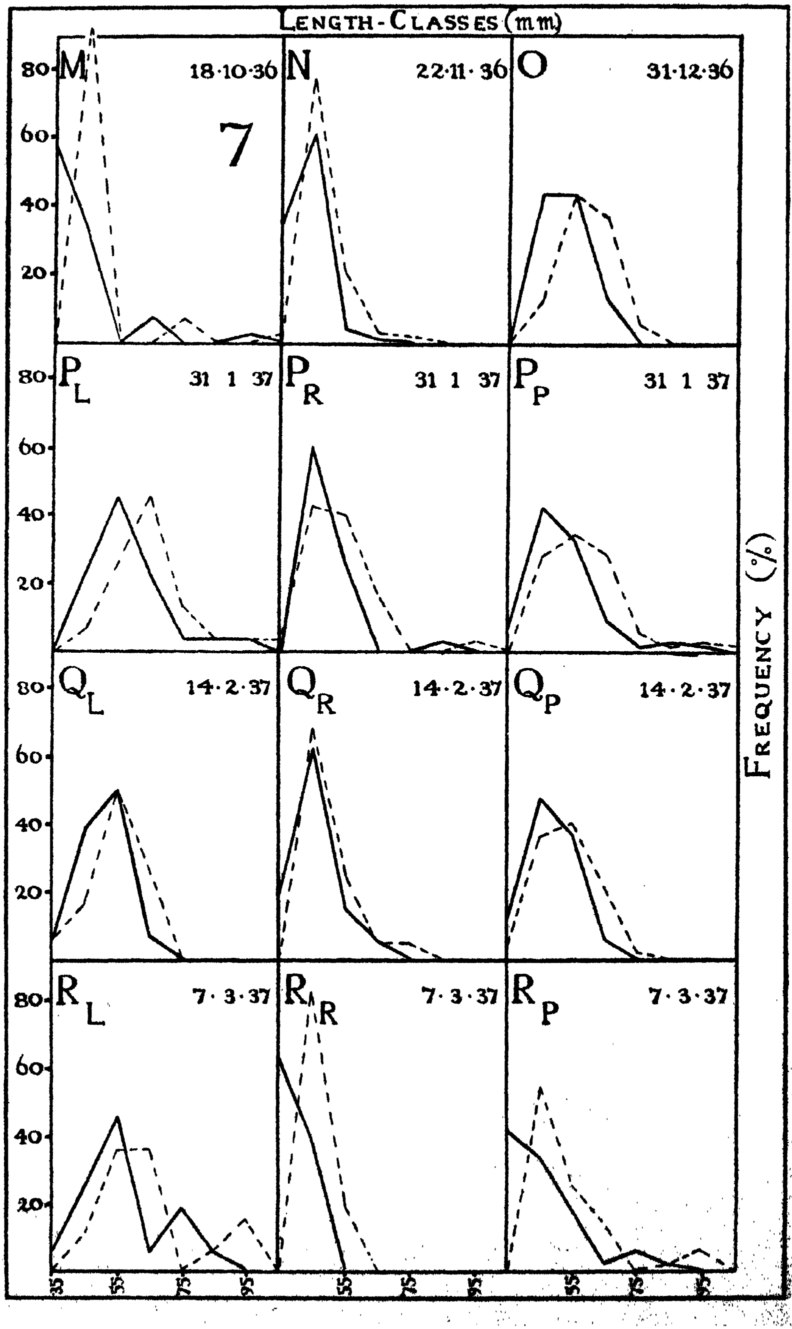
Fig. 6.—The same. 10-mm. classes.


3
4
250
200
150
100
50
34
61
91
32·5
62·5
92·5
5
6
400
350
300
250
200
150
100
50
32·5
104·5
182·5
35
105
185

PLATES XX, XXI, XXII

FIG. 7, A-X.—Seasonal frequency polygons of standard length (Punchbowl Creek). Suffixes L, R, P denote, respectively, sample from *Larnoo* section of Creek, sample from Reserve section, and pooled samples from the two sections. Samples without suffix from *Larnoo* section.


LENGTH-CLASSES (mm.)
A 25·11·34
B 2·12·34
C 6·1·35
D 10·2·35
E 10·3·35
F 7 4 35
G 18·8·35
H 8·10·35
I 24·11·35
J 15·12·35
K 27·9·36
L 4·10·36
7
80
60
40
20
35
55
75
95
FREQUENCY (%)


LENGTH-CLASSES (mm)
FREQUENCY (%)
M 18·10·36
7
N 22·11·36
O 31·12·36
P_L 31 1 37
P_R 31 1 37
P_P 31 1 37
Q_L 14·2·37
Q_R 14·2·37
Q_P 14·2·37
R_L 7·3·37
R_R 7·3·37
R_P 7·3·37
80
60
40
20
35
55
75
95

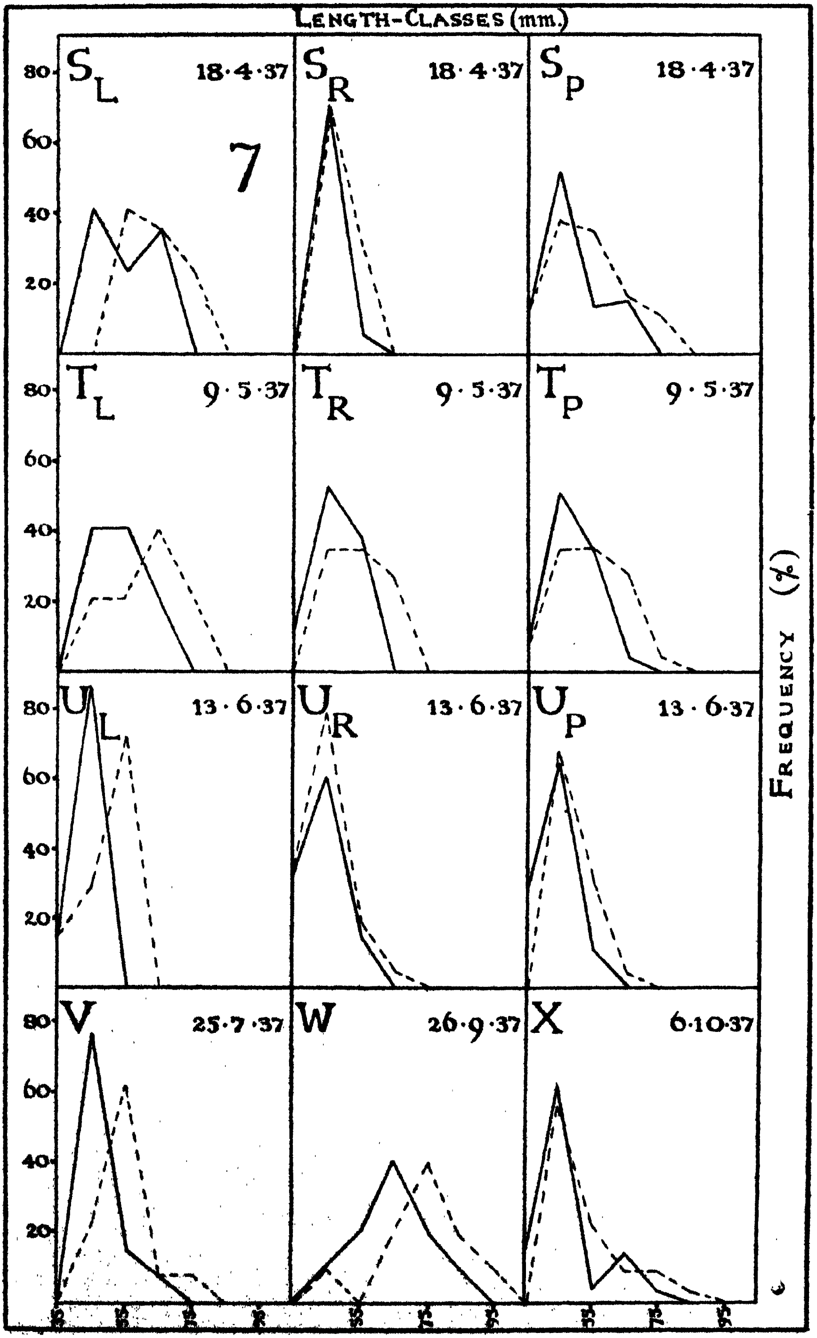
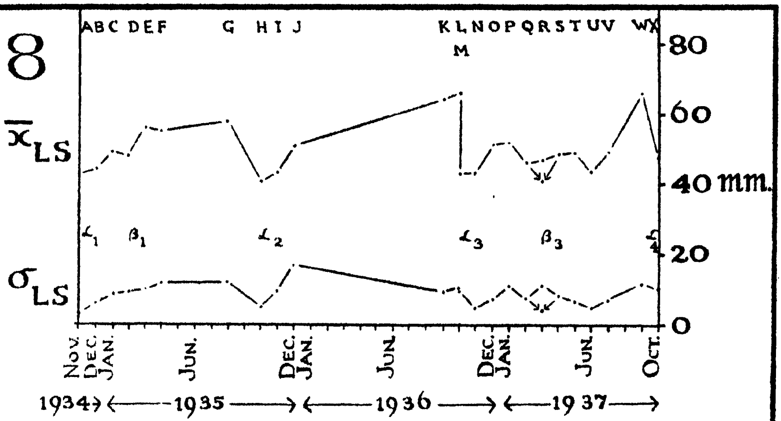

LENGTH-CLASSES (mm.)
FREQUENCY (%)
S_L 18·4·37
7
S_R 18·4·37
S_P 18·4·37
T_L 9·5·37
T_R 9·5·37
T_P 9·5·37
U_L 13·6·37
U_R 13·6·37
U_P 13·6·37
V 25·7·37
W 26·9·37
X 6·10·37
80
60
40
20
35
55
75
95
55
75
95
55
75
95

PLATE XXIII

FIG. 8.—Curves of seasonal variation (Punchbowl Creek) of mean standard length and of standard deviation of standard length.

FIG. 9.—Growth-curves. A, length to origin of dorsal fin; B, length to origin of pelvic fin; C, depth of body (maximum); D, length of caudal peduncle; E, depth of caudal peduncle (minimum); F, length of caudal fin; G, length of head; H, horizontal diameter of eye; I, eye in head; J, depth of caudal peduncle in its length: all plotted against standard length. Direct plotting.

8


A B C D E F G H I J K L M N O P Q R S T U V W X
$\bar{x}_{LS}$
σ_{LS}
α_1 β_1 α_2 α_3 β_3 α_4
80
60
40 mm.
20
0
Nov. Dec. Jan. Jun. Dec. Jan. Jun. Dec. Jan. Jun. Oct.
1934 ← 1935 → ← 1936 → ← 1937 →

9

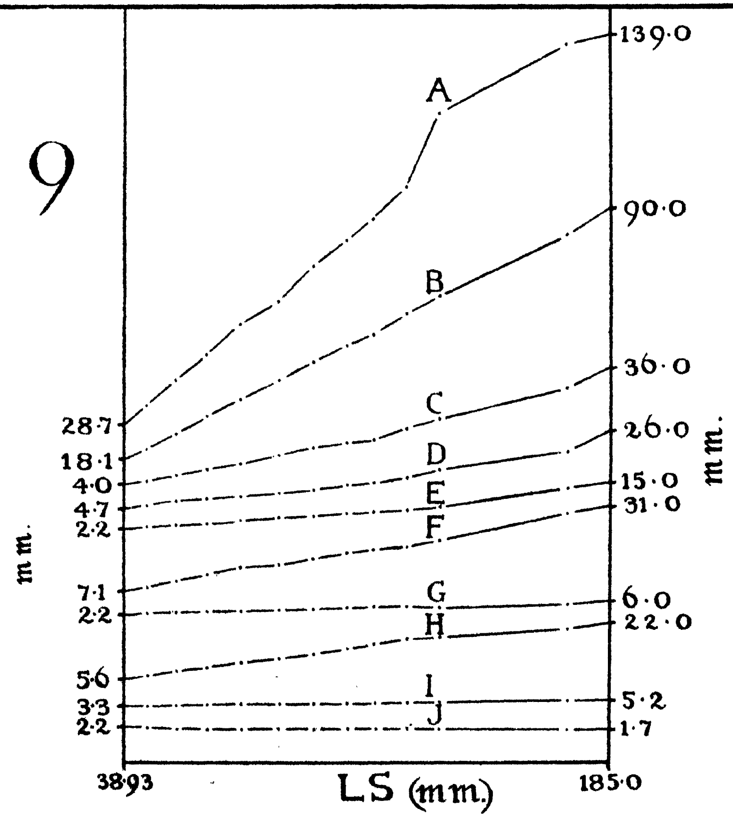

A
B
C
D
E
F
G
H
I
J
28·7
18·1
4·0
4·7
2·2
7·1
2·2
5·6
3·3
2·2
139·0
90·0
36·0
26·0
15·0
31·0
6·0
22·0
5·2
1·7
mm.
mm.
38·93
185·0
LS (mm.)

PLATE XXIV

FIG. 10.—Growth-curves. Lettering as in Fig. 9. Logarithmic plotting.

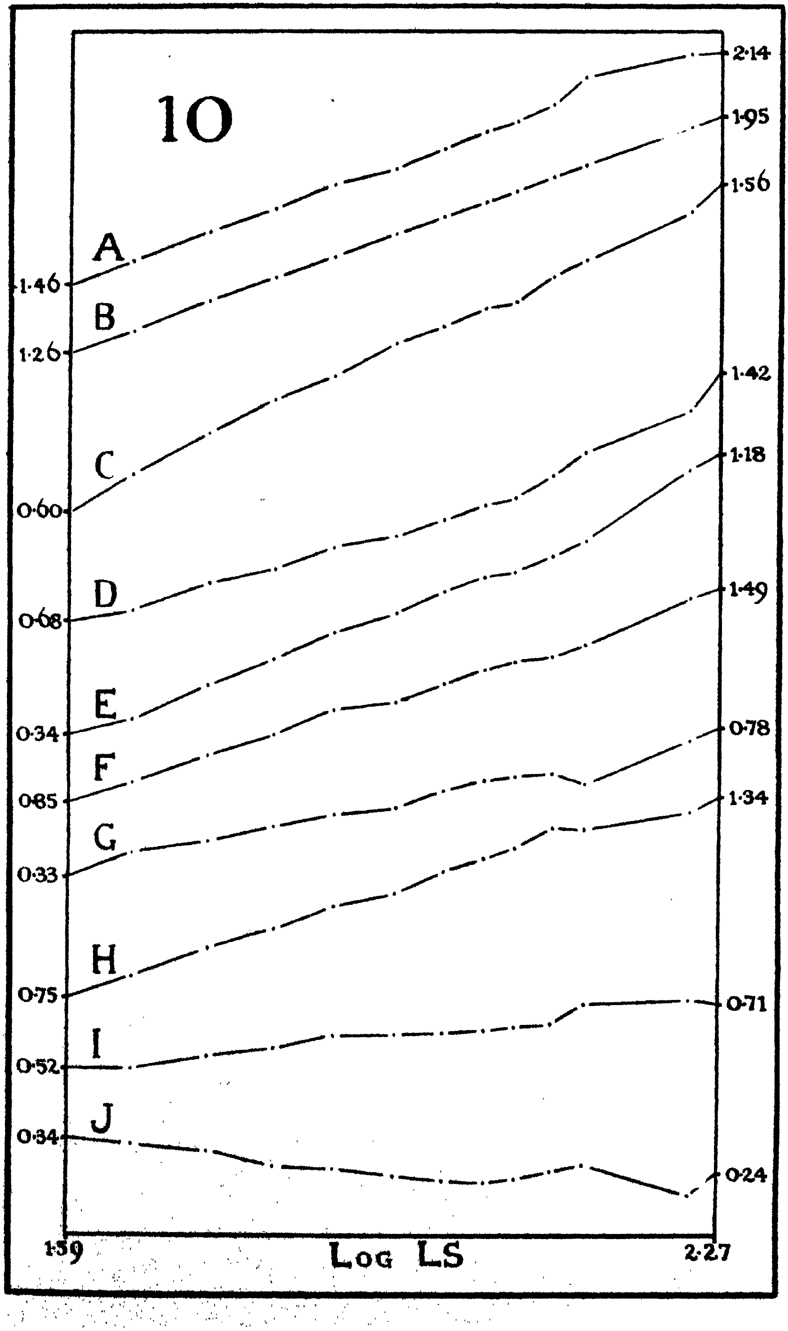
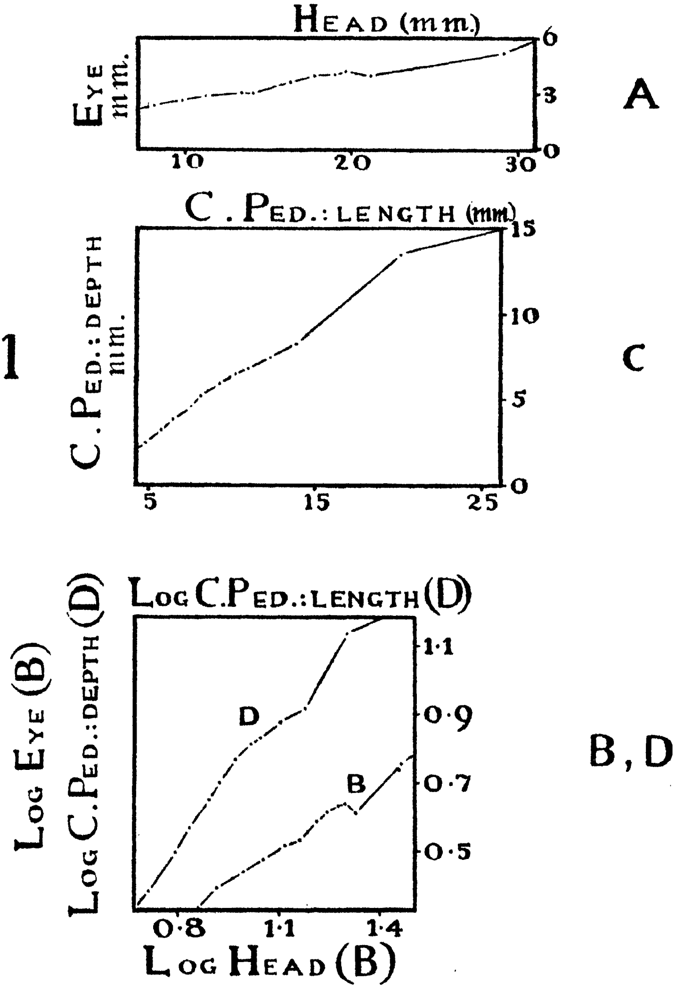

10
A
1·46
2·14
B
1·26
1·95
C
0·60
1·56
D
0·68
1·42
E
0·34
1·18
F
0·85
1·49
G
0·33
0·78
H
0·75
1·34
I
0·52
0·71
J
0·34
0·24
1·59
Log LS
2·27

PLATE XXV

FIG. 11.—Growth-curves. Eye on head: A, direct plotting; B, logarithmic plotting. Depth of caudal peduncle on length of caudal peduncle: C, direct plotting; D, logarithmic plotting.

FIG. 12.—Axial growth-gradients.

11


HEAD (mm.)
EYE mm.
6
3
0
10
20
30
A
C. PED.: LENGTH (mm)
C. PED.: DEPTH mm.
15
10
5
0
5
15
25
C
LOG C. PED.: LENGTH (D)
LOG EYE (B)
LOG C. PED.: DEPTH (D)
D
B
1·1
0·9
0·7
0·5
0·8
1·1
1·4
LOG HEAD (B)
B, D

12

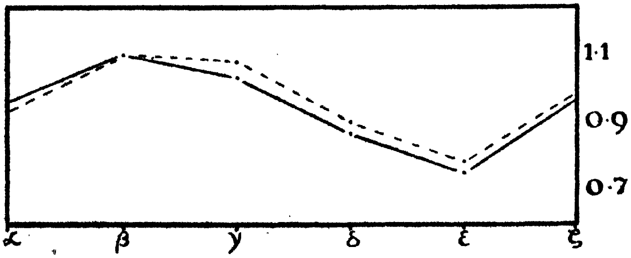

1·1
0·9
0·7
α
β
γ
δ
ε
ζ

PLATE XXVI

FIG. 13.—Duration of extra-aqueous survival. M is weighted average of A-F.

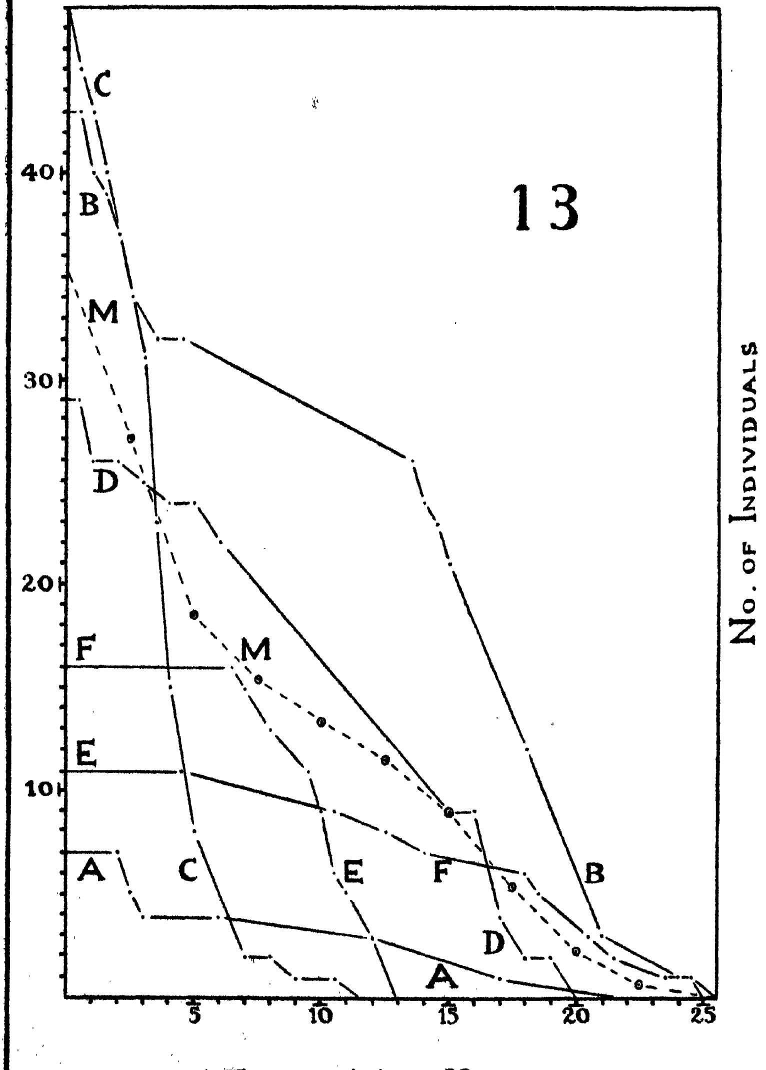
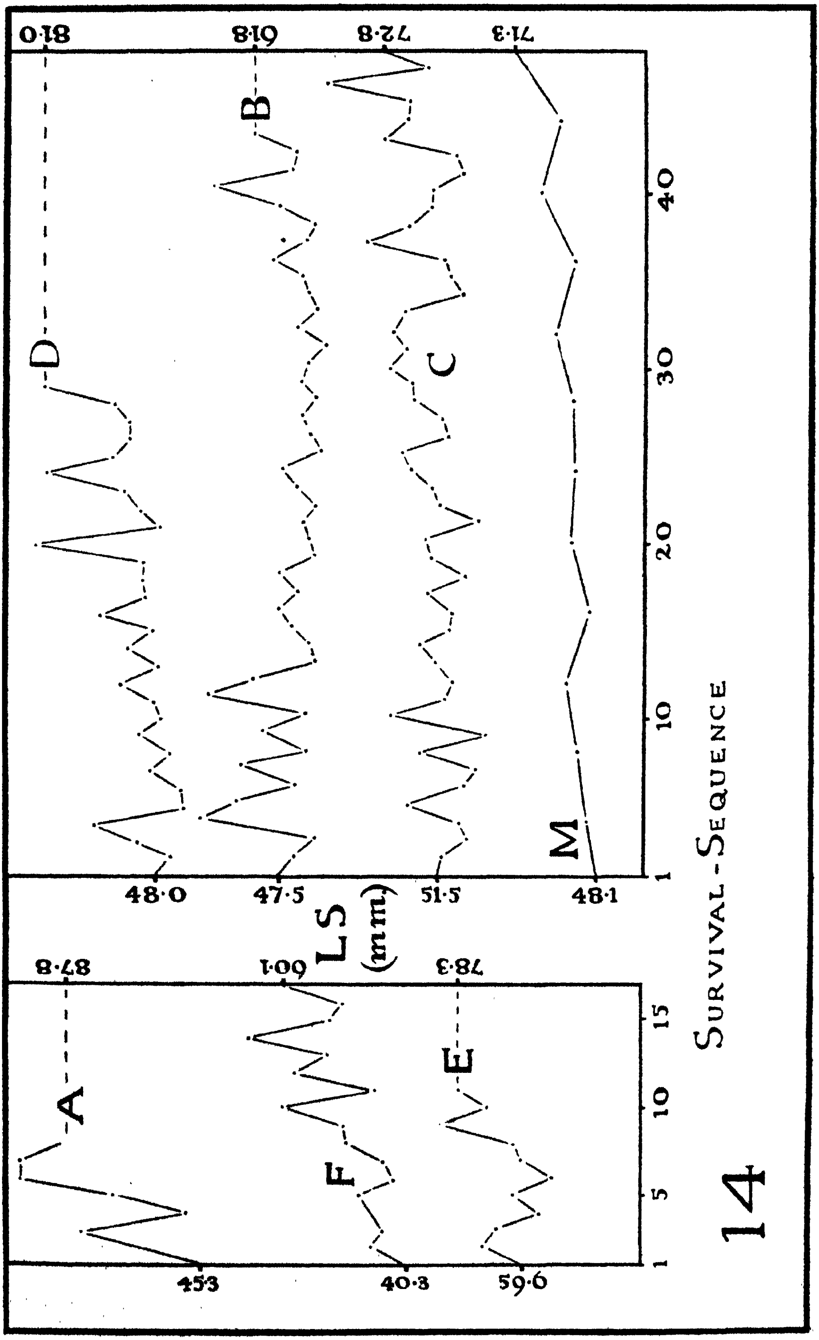

13
C
B
M
D
F
M
E
A
C
E
F
B
D
A
40
30
20
10
5
10
15
20
25
ELAPSED TIME : HOURS
NO. OF INDIVIDUALS

PLATE XXVII

FIG. 14.—Standard length plotted against survival-sequence—showing greater viability of larger individuals. M is weighted average of A-F.


81·0
61·8
72·8
71·3
D
B
C
M
48·0
47·5
51·5
48·1
1
10
20
30
40
SURVIVAL - SEQUENCE
LS (mm)
87·8
60·1
78·3
A
F
E
45·3
40·3
59·6
1
5
10
15

14

Notes

Tasmanian Trilobites

Attention is directed to a paper entitled 'Notes on Some Ordovician Faunas of Tasmania', by Teiichi Kobayashi, published in the Japanese 'Journal of Geology and Geography', Volume XIII, Numbers 1 and 2, March, 1936, page 178.

The learned author is a world-famous palaeontologist, and Tasmanian geologists express their appreciation of this interesting contribution to one of our problems.

The conclusion reached by the author from examining material from Caroline Creek and the Florentine Valley is that the trilobite fauna preserved in the sandstones of these localities are of Lower Ordovician age, not Cambrian as previously considered. These sandstones are regarded by Tasmanian geologists to be the lowest members of the extensive series of rocks which lie between the Pre-Cambrian schists and the West Coast conglomerates (base of the Silurian). The effect of this revision of fossil evidence will be to remove *Cambrian* as a term from our successional nomenclature, and confirm the generally accepted view that the very extensive and economically important beds which underlie the West Coast Range Conglomerate Series (e.g., Read-Rosebery Schists, Dundas Slates, Mathinna Slates, Balfour Slates) are of Ordovician age.

Kobayashi describes a new genus under the name *Tasmanocephalus.* This replaces the forms described as *Conocephalites? stephensi* Etheridge. The genus (three species) of *Ptychoparia?* disappear, but the author is not prepared to redescribe these forms from the material available. *Dikelocephalus florentinensis* becomes *Asaphopsis florentiensis* Etheridge, and *Dikelocephalus tasmanicus* Etheridge is regarded as similar to the genus *Tachungshania*, but of uncertain species.

Kobayashi also refers to the occurrence of *Rebeiria* or *Rebeirella* in the Table Cape Conglomerates, and assigns a Silurian age. A note of caution must be sounded here, since these fossils were found in Permian glacial tillite, associated with material some of which has not been found *in situ* in Tasmania.

In an associated paper (*ibid.*, p. 163) the author states interesting views on the distribution of the *Dikelokephalininae*, and shows the relationship between the lower Ordovician fauna of Tasmania and that of Southern Europe, China, and Northern America, suggesting a connecting link in dispersal between Southern Europe and Asia on the one hand, and Northern America on the other, as to which Tasmania can supply vital data.

In view of this recent work, it is suggested that the term *Dikelocephalus Sandstones* should be discontinued, and replaced by the term *Caroline Creek Series.* It is apparent that the interesting fauna of the Caroline Creek and Tim Shea (Florentine) sandstones is worthy of more detailed attention than has hitherto been accorded.

A. N. LEWIS.
8.11.37.

Biological Survey of Tasmania

Early in 1937 a movement was set on foot by a committee of scientists resident in Hobart to undertake a biological survey of the State.

Among the purposes of the projected survey are the determination of the distribution of plants and animals of especial interest within the State; the preparation of lists of the described fauna and flora; ecological surveys of selected districts; and an analysis of the effect of introduced animals and plants on the indigenous fauna and flora. It is expected that the survey will yield information of great interest, and will probably bring to light forms of life previously unknown to science.

The headquarters of the survey are at the Tasmanian Museum, Hobart, and the Director of the Museum, Dr. J. Pearson, is the Chairman of the Executive Committee of the Survey. Funds are being made available by the Australian and New Zealand Association for the Advancement of Science, the Commonwealth Science and Industry Endowment Fund, the State Fauna Board, and by the Forestry Department.

The Royal Society of Tasmania

Annual Report

1937

The annual meeting was held in the Society's Rooms, Tasmanian Museum, Hobart, on the 8th March, 1937.

The following were elected as members of the Council for 1937:—Mr. H. Allport, Mr. S. Angel, Mr. W. H. Clemes, Dr. W. L. Crowther, Mr. J. W. Evans, Mr. W. H. Hudspeth, Dr. A. N. Lewis, Hon. L. M. Shoobridge, Mr. E. E. Unwin.

His Excellency the Governor nominated the following members as Vice-Presidents:—Mr. S. Angel and Dr. W. L. Crowther.

The Council at its first meeting made the following appointments:—

Chairman of the Council: Mr. W. H. Clemes.

Secretary: Dr. Joseph Pearson.

Hon. Treasurer: Mr. S. Angel.

Standing Committee: Dr. Lewis, Mr. Unwin, and the Secretary.

Representatives of the Society on the Board of Trustees of the Tasmanian Museum and Art Gallery and Botanical Gardens:—Mr. W. H. Clemes, Mr. S. Angel, Mr. W. H. Hudspeth, Dr. A. N. Lewis, Hon. L. M. Shoobridge, Mr. E. E. Unwin.

Ten meetings have been held during the year, and in addition to the lectures delivered scientific papers of considerable value and interest were submitted for publication.

(See abstract of meetings for abstracts of lectures, papers, &c.)

The Society's library continues to be used extensively by members and many others desiring historical and scientific information. During the year a number of new volumes have been added to the various sections. In December, 1936, the number of books totalled 18,733, and in December, 1937, 18,984, showing that 251 volumes have been added.

A very valuable gift to the library has been made by Mrs. L. Rodway, who has donated the whole of the botanical books belonging to the late Mr. Rodway. It is proposed to have these suitably labelled as the Rodway Memorial Library, and they should prove of great value to students of botany.

The membership for the year, compared with that of 1936, is as follows:—

	1936.	1937.
Honorary members	3	2
Corresponding members	3	3
Life members	7	7
Ordinary members	233	241
	246	253

During the year 16 names were removed from the membership owing to deaths, resignations, &c., and 23 new names were added.

The Council regrets to have to record that the following members have died during the year:—

Mrs. C. S. Agnew.
Dr. R. J. Tillyard.
Dr. R. G. Scott.
Lt.-Colonel G. Harrap.
Mr. Hector Ross.

During the year the rules of the Society have been revised and brought up to date, and it is hoped to print these revised rules during 1938.

A request was received for the publication of a classified index to the Papers and Proceedings published subsequent to the last published index, and the Council arranged for this work to be undertaken by several members of the Society. When the index is completed it will supply a long-felt want.

The Government has assisted again with the printing of the Papers and Proceedings, and this concession is greatly appreciated by the Council.

Abstract of Proceedings

1937

24TH FEBRUARY, 1937

A special meeting of the Royal Society of Tasmania was held on this date to celebrate the centenary of the arrival of Sir John and Lady Franklin in Tasmania.

His Excellency the Governor, Sir Ernest Clark, K.C.B., C.B.E., President of the Society, presided, and His Excellency the Governor-General, Lord Gowrie, was also present. The President opened the meeting by discussing the character of Sir John Franklin and the significance of his work in Tasmania. The Governor-General also spoke.

These speeches were followed by a paper by Mr. J. Reynolds on Sir John Franklin. Mr. W. Hudspeth then gave a paper on Lady Franklin, in which he drew upon personal letters which she wrote while in Tasmania. At the end of his paper Mr. Hudspeth showed a series of lantern slides dealing with the Franklin period.

The meeting then adjourned to the Museum, where a number of Franklin relics were examined which had been displayed temporarily in the Ethnographical Gallery.

8TH MARCH, 1937

Annual Meeting

The annual meeting was held in the Society's Rooms, Tasmanian Museum. The Vice-President, Mr. F. E. Ward, presided in the absence of the President, His Excellency the Governor.

The following were elected as members of the Council for 1938:—Mr. H. Allport, Mr. S. Angel, Mr. W. H. Clemes, Dr. W. L. Crowther, Mr. J. W. Evans, Mr. W. H. Hudspeth, Dr. A. N. Lewis, Hon. L. M. Shoobridge, Mr. E. E. Unwin.

Mr. Walter E. Taylor was appointed Hon. Auditor.

The following were elected members of the Society:—Professor F. R. E. Mauldon, Major W. T. Conder, Mr. T. V. Williams.

Dr. Joseph Pearson delivered an illustrated lecture on 'The Furniture of the 17th and 18th Centuries', of which the following is an abseract:—

> Dr. Pearson showed pictures of the different styles of chairs, cupboards, and tables, as they followed one on the other, treating the subject somewhat from the point of view of the student of comparative anatomy. He said the furniture of the 17th and 18th centuries was not only European, but

also colonial. The whole development hinged on the evolution of the chair. Until the 16th century the chair was hardly known in the home, being used only by kings and bishops and others in authority. Most men and women sat on forms or chests. Chairs were connected with State occasions, and particularly with churches. The early church chairs were stalls, with fixed seats, with legs forming part of a box, and often with a canopy. In the following type the arms disappeared. The strength and massiveness were gone, and at the beginning of the 17th century such chairs might be found in kitchen or cottage parlour. They were uncomfortable, but useful. The next type was plain, with no ornamentation except in the legs and the front stretcher. The back was upholstered. The chair was common throughout Europe. Another type of the same period was more elaborate, and was known as the Yorkshire or Derbyshire chair. A picture, taken in Java, showed a chair that was late Renaissance in style. It was still very uncomfortable. The next type was a great advance, having spiral turning in the legs, in the front and back stretchers, and in parts of the back. It first appeared in England about 1660. It was taken to the East by the Portuguese. The style originated in Europe, and was well known in the Gothic churches of the 13th and 14th centuries.

Dr. Pearson traced the rise of the spiral column and of the Flemish scroll, the development of cane seats and back, and the application of tapestry. The influence of the Huguenot craftsmen after the revocation of the edict of Nantes was described as affecting furniture design not only in England and Holland, but also in South Africa.

The development of the splat, or central panel, in the back of the chair, was shown gradually becoming smaller. The Spanish scroll was seen to grow by easy stages into the cabriole legs characteristic of the Georgian chair. Dr. Pearson described the work of Chippendale, Hepplewhite, and Sheridan, and said the 18th century ended in a very severe but pleasing tone. Cupboards, tables, gravestones, and so forth, were illustrated, and the influence of rococo decoration, with its lack of symmetry, was described. The Dutch burgomaster chair (about 1650), with its semi-circular back, was shown in several beautiful slides.

12TH APRIL, 1937

A meeting was held in the Society's Rooms on this date. In the absence of the President, His Excellency the Governor, the chair was taken by Mr. Henry Allport.

The following were elected members of the Society:—Miss E. I. Knight, Miss L. E. Knight, Miss N. Davern, Mr. W. J. T. Stops.

Dr. G. H. Hogg gave an interesting lecture entitled 'D'Entrecasteaux: An Account of His Life, His Expedition, and His Officers'. (See this volume, p. 53.)

10TH MAY, 1937

A meeting was held in the Society's Rooms on this date, Dr. W. L. Crowther presiding in the absence of the President, His Excellency the Governor.

The following were elected members:—Mr. H. C. Lewis, Dr. C. R. Brothers, Mr. E. W. Little.

Mr. J. M. Counsel delivered an illustrated lecture entitled 'The Italian Foundations of Painting from Michelangelo to Giotto', of which the following is an abstract:—

> Mr. Counsel said there was no acute aspect of human nature that was not illustrated in the story of the painters. He illustrated the work of Michelangelo, and said it showed the obstinacy with which the artist persisted in his claim that he was not a great painter but a sculptor. He employed the sculptor's methods, and this was evident in his drawing of the human figure. The lecturer referred to a collection of frescoes painted by Michelangelo, and pointed out that there was no ornament or background, but through all the examples of his work there was noticeable a rhythm, which was the life and soul of all great painting and sculpture.
>
> Mr. Counsel showed a painting of the Annunciation by Leonardo, and said it was one of the most notable examples of the science with which he built up his art. The whole work was a most scientifically thought-out production. Raphael was unique in that his work summed up all the progress that had gone before. This artist also had his moments of strong rhythm. Illustrations were shown of the work of Italian painters and their influence down to Giotto.

14TH JUNE, 1937

A meeting was held in the Society's Rooms. In the absence of the President, His Excellency the Governor, Mr. S. Angel presided.

The following members were elected:—Mr. C. E. Bisdee, Mr. L. A. Burt, Mr. D. A. Davie.

Mr. A. Lismer, A.R.C.A., Educational Supervisor of the Toronto Art Gallery, Canada, delivered an illustrated lecture entitled 'Art in a Changing World', of which the following is an abstract:—

> Mr. Lismer said art and life had become separated. Persons lived in a brittle, sophisticated world of commercialized entertainment and industrialized movies and radio. They passed through streets that were often ugly and depressing, and analysed and speculated on the nature of the physical universe, but failed to keep alive within them the wonder and awe at their actual passage through life. It was essential to human existence that they should at least try to summarize their responsibility, and face the evidence that in life to-day art was missing grievously.
>
> Art is not something outside ourselves, a perfection, a completion of life. It is within, a developing force, a vitality, and a rhythm. It is consciousness of environment, and understanding of the significance of the beauty and character of things in nature and in the human mind. We cannot look round in our cities to-day and see without pain all the ugliness that man has created to express this possessiveness—the ugly rows of houses, the mean little shops, the brutally stark factories, and the sordid railway sidings. Compare these with a little Gothic town or an English village, and feel the difference and the price we have paid when science and industry have created standards of living, and not art. To bring the responsibility down to our own problems when so many have failed in the eternal combat between materialism and idealism is a gigantic task, but it will have to be tackled again and again in a thousand ways. Through art we can achieve an educational revival that would be an antidote to banality and commonplace living. There is one supreme art possible through the non-creative individual, and that is the art of appreciation.

Mr. Lismer said he made no apology for introducing idealism into education. Perhaps that was what was needed more than anything else. He did not think that reading, writing, and arithmetic were fundamentals of education at all. None of them was good unless illustrated by a creative attitude. They were held down by what parents thought about education, and by what industrialists thought about it. The most important things were the understanding of leisure and the use of it. It was in leisure time that all the good or all the mischief in life was done.

If the child were given art in his most rhythmic and vital period of growth, and was fed with the means to keep his senses keen, it did not matter whether he became an artist or not. But it did matter whether he adopted too early a merely predaceous attitude to his fellow men, or whether he saw life creatively, and with understanding and recognition of the various stepping-stones to higher places. He advocated the encouragement of the understanding of contemporary art, which included all endeavours to create civic beauty and to preserve all natural playgrounds and beauty spots.

The lecturer showed a number of lantern slides illustrating art in various forms. He pointed out from the pictures that their value was not represented merely in the scenes portrayed, but in the character, either of the persons or places, they revealed. In a number of pictures by children, he stressed the creative imagination and dynamic force which they displayed. He urged that children should be allowed to cultivate their originality, rather than to receive a stereotyped education.

12TH JULY, 1937

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

Miss M. E. Griffiths was elected a member of the Society.

Mr. L. Cerutty delivered a lecture entitled 'Science and Utopia', of which the following is an abstract:—

Justice and harmony were features of the Ideal State described by Plato; More described perfect concord as characteristic of Utopia; but these and other inventors of the perfect society have failed to suggest a means of attaining such perfection. It is characteristic of most of us that we prefer to concentrate on the problems of the moment and leave the designing of Utopias to visionaries; indeed, it becomes more difficult every day to guess the probable trend of our civilization, so potent are the effects of science upon it.

So great is the power of applied science that some have begun to distrust it. The brilliant satire of the scientific millenium described by Aldous Huxley, and the increasing accusation that the scientist is morally responsible for the horrors of modern warfare, are indications of such distrust. One can understand the plea for a ten years' holiday in scientific investigation.

Nevertheless science has something definite to offer society in addition to material gifts. Modern Utopias inevitably are based upon such material progress, but we should do better to base our plans less upon the results of scientific investigation—which may be readily applied in a foolish fashion—and more upon the methods of science.

The search for truth is essential. Professor Hogben has described our age as retreating from reason, and one has only to consider the amazing theories which are invented to support political systems abroad, and the still more amazing claims and suggestions of party politicians at home, to agree with him. Compare this passion for falsehood with the passion for truth which has marked, for instance, inquiry into the structure of matter by the physicist and the chemist; the difference in the attitude to truth and to reason is startling.

Then, again, the faith of the scientist in ultimate harmony and order is essential to progress. His faith in natural law as correlating the confused mass of facts carries him in advance of his observations, and belief in the truth of his speculations has at times carried him on in spite of neglect by his contemporaries, as witnessed by the lives of Kepler and von Mayer.

A respect for truth and faith in the possibility of ultimate harmony will help in the attainment of the Utopian 'perfect concord'.

At the conclusion of the general meeting members adjourned to the Art Gallery for the unveiling of a portrait of the late Leonard Rodway, C.M.G. Dr. Crowther, in a short speech, asked the Governor to unveil the portrait, and His Excellency did so, after having spoken on certain aspects of the life of the late Mr. Rodway. Members of the family of the late Mr. Rodway were present at the function, as well as members of the Royal Society and subscribers to the Rodway Memorial Fund.

9TH AUGUST, 1937

A meeting was held in the Society's Rooms, Dr. W. L. Crowther presiding in the absence of His Excellency the Governor.

The following members were elected:—Mrs. Walter Gellibrand, Mrs. W. H. Williams, Dr. H. D. Gordon, Mr. A. J. Halls, Mr. W. E. Mitchell, Dr. J. S. Reid, Hon. Alan Wardlaw, M.L.C.

Illustrated papers on Forestry Problems were given by Mr. S. W. Steane, Mr. C. G. Stephens, and Mr. J. W. Evans:

Mr. Steane took as his subject 'Forest Problems'. He said the principal functions of State forestry are to produce continuously certain defined minimum quantities of timber and other forest products, and to provide continuously certain desirable forest effects.

The problem of the protection of forests depends for its satisfactory solution on the support of public opinion, since practically all forest fires in Tasmania are started by human agency, and fires, although the most important menace to forests, are not the only ones. After fire-lighters, splitters, who test trees to see whether they will split easily, are the worst offenders. They damage innumerable trees, and in many cases the wounds give entrance to insect borers, which in the total cause a very serious volume of damage. In conclusion, reference was made to the botanical problem offered by Tasmania's eucalyptus trees.

Mr. C. G. Stephens, speaking of 'The Tree and the Soil', said his talk was divided into two portions, namely, the effect of the soil on the tree, and the effect of the tree on the soil and its products. The former was illustrated by reference to the growth vigour of *Pinus radiata* over a wide series of soils, varying from very acid humus podsols to slightly alkaline soils over limestone. It was also shown how different soil types, by producing trees of different configuration, are responsible for varying grades of timber. The suitability of certain species of trees for different soil conditions was illustrated.

The latter half of the talk was devoted to quoting a miscellaneous series of facts illustrating the various points. Mention was made of the effect of trees on soil type, the value of trees as shelter-belts, particularly on the North-West Coast and in the Midlands of Tasmania, and the response of crops to shelter, where provided.

Mr. Evans spoke on 'Forest Entomology'. He said that insects comprise the greater part of the animal inhabitants of forests, and it is probable that their beneficial activities more than offset their destructive ones. Beneficial insects comprise those that assist in the disintegration of dead timber, scavengers, and parasites and predators of noxious insects. Amongst the harmless forest insects occur certain representatives of primitive groups that are of great scientific interest.

A number of forest insect pests were described and their habits briefly referred to, and in conclusion it was mentioned that no forest entomological research had ever been undertaken in Tasmania, although several important problems are in need of investigation.

13TH SEPTEMBER, 1937

A meeting was held in the Society's Rooms, Mr. S. Angel presiding in the absence of His Excellency the Governor.

The following members were elected:—Miss O. M. Pink, Mr. R. F. Cane.

The following motion was proposed by Mr. N. Oldham, seconded by Mr. A. L. Butler, and carried unanimously:—

> 'That the Council of this Royal Society, in conjunction with the Trustees of the Tasmanian Museum and Art Gallery, take into consideration the placing in this building of some permanent suitable tribute to the memory of the late J. W. Beattie'.

Professor F. R. E. Mauldon gave a lecture entitled 'Economic Science and the Community', of which the following is an abstract:—

Professor Mauldon traced the concept of political economy from the time of Aristotle, when it was used narrowly to describe the financial aspect of the art of government, to the late 19th century, when it had come to have reference to a highly theoretical system about the nature of those economic forces to which economic policy must accommodate itself.

Economic science is the core of a group of intellectual and practical disciplines now called economics. The service which the science can give the community will be chiefly in providing tested criteria by which probable results of practical proposals may be gauged in advance. The economist makes no pretence to be a seer or a prophet, but there must always be an element of prophetic reasoning in his work, just as there must be in the reasoning of the physical scientists. Economic science can and does bring the spirit of science to the consideration of practical problems in every department of economic life, thus encouraging rational, i.e., ordered, thinking. It is available to show the most economical relations between means and ends, between path and goal. Some things economic science cannot do. It is often expected of the economist that he should first assume responsibility for myriad individual decisions which on aggregate forces produce the disturbing fluctuations of the economic system, and then, by some means or other, acquire power to still the waves of the storm when it breaks. The economist can do neither of these two things.

As a citizen, the economist is expected to give certain specialised services as a teacher, an adviser, and as a collaborator. These are rightful roles for him to occupy, provided he is aware of the limitations and dangers attached to them. He should never neglect the consideration of the 'long period', whatever the expediencies of the 'short period' to which those he may be advising or helping may be driven. He must avoid the habit of political-mindedness. He must expect to forego the pleasures of vigorous partisanship, and be careful lest reforming zeal destroy his capacity for dispassionate analysis. He must expect to tread a straight and difficult way, beset by temptations and misunderstandings. Even though his stand for tolerance, fairness, and dispassionate search for truth is apt to be at a heavy discount in the popular estimation, it is the essential basis of the contribution which economic science gives to the community.

11TH OCTOBER, 1937

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

The following new members were elected:—Mr. B. J. F. Ralph, Mr. T. J. Hallam.

As the rules of the Society were out of date the Council had revised them. The revised rules were submitted to this meeting and, subject to certain amendments, were passed.

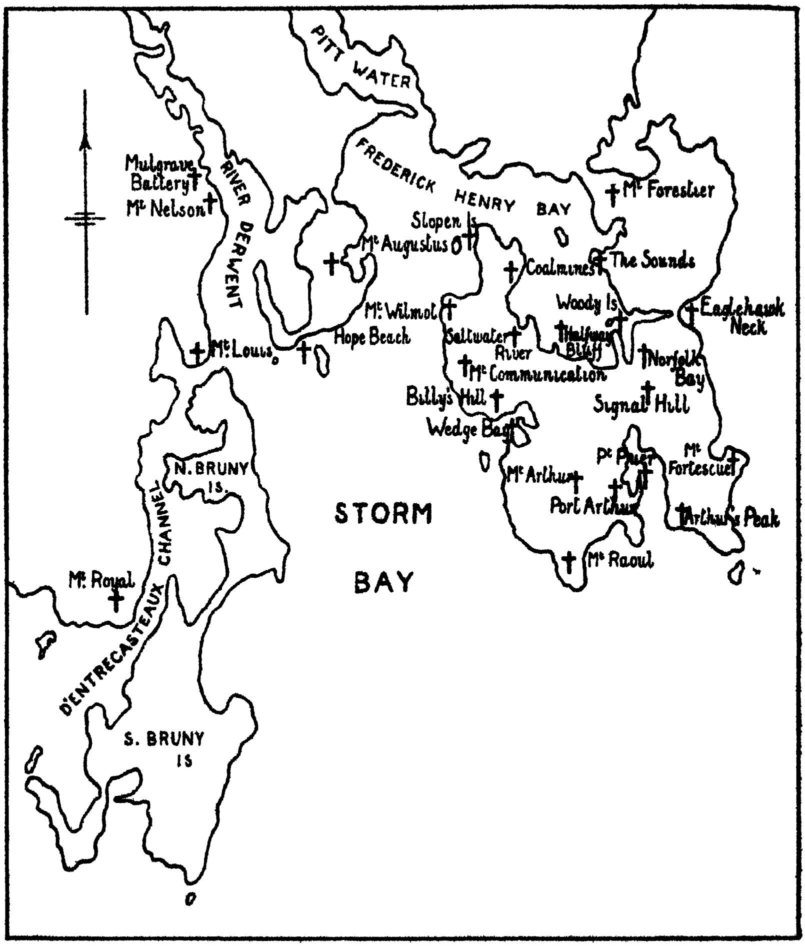
Mr. W. E. Masters gave an interesting illustrated lecture entitled 'The Semaphore Telegraphic System of Early Van Diemen's Land', of which the following is an **abstract**:—

Prior to the advent of the electric telegraph and telephone in this island all messages relating to shipping, as well as Government, military, and civil messages, were from the middle twenties of last century transmitted by means of moving-arm semaphores.

The first semaphore used was an adaptation of a two-armed type which had been introduced into England a few years before.

Although the first moving-arm semaphore was introduced into the Royal Navy about 1816, it was not until some years later that the two-arm type, used chiefly for signalling the movements of shipping, came into use on the coasts of England. In the middle twenties this type of semaphore was introduced into Van Diemen's Land—displacing an earlier system of flags and balls used to signal arrivals and departure of shipping. The code then in use appears in the 'Hobart Town Almanac' (James Ross), 1829. The first chain of stations was Mulgrave Battery, Mt. Nelson, Mt. Louis (near Pearson's Point), and Mt. Royal (near Three-Hut Point). These semaphores had two arms, one above the other. Each arm revolved, and had three positions on each side of the staff. Certain positions of either or both arms denoted certain numbers, but there was no orderly rotation of the arms as in the later types, and the code was limited and hard to memorise. The apparatus required to cause the arms to revolve was cumbersome, and apt to become easily damaged.

In the thirties an improved type came into use. It had three single revolving arms, the top arm representing units, the middle one tens, and the lower one hundreds. Each arm could make positions indicating 1, 2, and 3 on one side of the staff, and 4, 5, and 6 on the other side, but there was no provision for making 7, 8, and 9. The signals were all done by numbers, and at no time during the semaphore telegraph period were the positions of the arms used to denote letters, as in the Army and Navy to-day.



The last and greatly improved type was introduced in the thirties, and under Captain Charles O'Hara Booth, of the 21st Fusiliers, the fifth, and in many respects the ablest, of the commandants at Port Arthur, this type of semaphore became a most useful and efficient telegraph. The semaphore now had three pairs of double arms; each arm moved on one side of the staff only, and the cumbersome revolving apparatus was discarded. The top pair represented units, the middle pair tens, and the lower pair hundreds, as before, but provision was now made to signal 7, 8, and 9. No cypher was necessary, as when, e.g., the arms of the units pair had counted up to 9, and it became necessary to count 10—the arm on the middle, or 'tens', pair was raised to make '1', signifying 10, and so on. Captain Booth was an enthusiast, constantly visiting the different stations, occasionally moving them to more suitable sites, constantly improving the gear, and keeping his signallers up to a high state of proficiency.

An elaborate code was compiled; each letter of the alphabet had its own number, and words beginning with the different letters all had numbers. Long sentences including questions, answers, orders, &c., were grouped under headings arranged for quick reference. The method of working the arms and conducting the signalling were all clearly set out in the code-books. Three flags were used, viz., the Blue Peter, the 'Preparative' or 'Get ready' flag displayed when a message was about to be sent; the tricolour, to denote that the number shown on the arms was a number merely, and not a number in the code; and the 'chequered' or 'millesimal' pennant, to denote 'thousands'. On the arms alone it was possible to count up to 999. By making a number on the arms with the pennant at half yard-arm, the number was read as 'thousands'. If additional figures were to be added, a further number was made on the arms with the pennant run up to the yard-arm. So efficient did the signallers become that it was possible on a clear day to send a message from Port Arthur to Hobart Town and get a reply within fifteen minutes, passing through five stations each way. High winds, smoke, or fog hindered the signallers, and no provision was made for signalling at night by lamps, although at an early stage this improvement was suggested by Captain Booth.

The map shows the principal stations in the south of the island. The semaphores were set in some cases on the tops of high trees on hills or prominent bluffs, and temporary semaphores were used by the military posts at different places in the island, these, however, forming no part of the regular circuits. On the Tamar fine work was done until 1869 by stations on Windmill Hill, Mt. Direction, Mt. George, and Low Head. These were done away with when the cable was laid from the Victorian coast to Low Head. The last message made on a semaphore was that shown on the Mt. Nelson station, just prior to the dismantling of the mechanism ofter the installation of the telephone, and the word signalled was 'forgotten'.

The old signal station at Princes' Park, Castray Esplanade, Hobart, is the last remaining building in the former chain of stations in the South. The semaphore at Battery Point was erected, in the first place, at the top of the hill, approximately in the position of the present signal staff, but was later removed to what had been the guard-house at the Mulgrave Battery, and at this old building, still standing, all telegrams were sent and received for many years until the electric telegraph rendered it obsolete. The Hobart Museum has in its possession a fine model, made by the late Mr. Thomas Bennison, showing this station in its working days. Portion of the standards for the dead-eyes of the rigging still remain in front of the old building, showing that the semaphore staff stood in the same position as the flagstaff of to-day. The lecture was illustrated by a working model and lantern slides.

8TH NOVEMBER, 1937

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

Mr. Cecil W. Baldwin was elected a member of the Society, and Mr. Francis H. Foster was nominated for membership.

His Excellency explained that a meeting had been held on Friday, 29th October, 1937, at 5 p.m., when it had been decided to open a fund, to be controlled by the Council of the Royal Society, with the object of purchasing modern books on Australian history, geography, and anthropology, as a memorial to the late J. W. Beattie.

The following papers, submitted for the 1937 Papers and Proceedings, were tabled, and referred to the Standing Committee:—

'Some Biometric Problems of the Galaxiidae', by E. O. G. Scott, B.Sc.

'The Morphology of the Head of Homoptera', by J. W. Evans, M.A., F.R.E.S.

'Colour Variations and Distribution of the Tasmanian Brush Opossum', by J. Pearson, D.Sc., F.R.S.E., F.L.S.

'A Record of Volcanic Activity in Tasmania during Triassic Times', by A. N. Lewis M.C., LL.D., and A. H. Voisey, M.Sc.

'The Male Meiotic Cycle in the Genus Eucalyptus', by A. L. McAulay, F.Inst.P., and F. D. Cruickshank, B.Sc.

'Evidence for the Existence of a Natural Hybrid between *Eucalyptus globulus* and *Eucalyptus ovata*', by A. L. McAulay, F.Inst.P.

'The Hybridization of the Eucalypts', by R. G. Brett, B.Sc.

'Aboriginal Rock Carvings Found at Trial Harbour', by J. F. Jones.

The Fifth R. M. Johnston Memorial Lecture was delivered by Sir David Rivett, K.C.M.G., M.A., D.Sc., Chief Executive Officer of the Council for Scientific and Industrial Research. Before the lecture His Excellency the Governor presented the R. M. Johnston Memorial Medal to Sir David Rivett. Sir David delivered a lecture on Wool, an account of which will be published in next year's Papers and Proceedings.

After the lecture a conversazione was held in the Art Gallery.

Northern Branch

Annual Report, 1937

The 1937 session was one of the most successful yet experienced. An outstanding event was the completion of the Fall-Hartnoll Memorial Wing at the Queen Victoria Museum and Art Gallery, as a result of which the Branch found, for the first time in its history, a definite home. Permission has been given by the Launceston City Council for the Branch to make the library and lecture-room in the new wing its permanent headquarters. Ordinary monthly meetings and Council meetings are now held here; and, with shelf-space available, the Branch is now attempting to organise and extend its library. Arrangements have been made during the present session for a varied selection of current scientific periodicals to be forwarded in monthly batches from the parent Society, and to be laid on the table for the convenience of members in the Branch's room.

The May meeting was held at the Public Library, the June meeting at the State High School, and the remaining meetings at the Museum.

24TH MAY, 1937

Annual Meeting and Public Lecture

Mr. A. L. Meston presided. The following were elected as members of the Branch Council for 1937:—Mr. A. L. Meston (President), Hon. Tasman Shields, Messrs. R. S. Padman, F. Heyward, W. R. Rolph, J. E. Heritage, D. V. Allen, F. Smithies, J. R. Forward, E. O. G. Scott (Secretary). Mr. R. S. Padman was re-elected Honorary Auditor.

The statement of accounts, which disclosed a credit balance of £25 17s. 8d., was read and adopted.

The annual meeting was followed at 8 p.m. by a public meeting, arranged by the Tasmanian Branch of the Australian Forest League, in conjunction with the Branch. Addresses were given by Dr. Joseph Pearson ('Fauna and the Forests'), Mr. G. Wright ('Seasoning Processes of Timber'), Hon. Alan Wardlaw ('Objects of the Forest League'), Mr. C. E. H. Ferguson ('History of the Tasmanian Branch of the League'), Mr. F. Smithies (running commentary on two educational films, 'Lumbering in Canada' and 'Reafforestation').

17TH JUNE, 1937

Mr. A. L. Meston presided. Illustrated lecture: 'Creative Education', by Mr. A. Lismer, A.R.C.A., Educational Supervisor, Toronto Art Gallery. This meeting was open also to ticket-holders of the New Educational Fellowship.

19TH JULY, 1937

Mr. A. L. Meston presided. Illustrated lecture: 'D'Entrecasteaux: An Account of His Life, His Expedition, and His Officers', by Dr. G. H. Hogg.

5TH AUGUST, 1937

The Secretary presided. Illustrated lecture: 'Modern Museum Methods', by Mr. Frank Tose, Chief of Exhibits, California Academy of Sciences.

6TH SEPTEMBER, 1937

Mr. A. L. Meston presided. Illustrated lecture: 'Two Eyes as One', by Mr. R. S. Padman.

COUNCIL MEETINGS.

Meetings of the Council were held on 23rd April, 4th June, 6th July, 24th August, and 30th November.

Walter E. Shimmins, Acting Government Printer, Tasmania

PAPERS & PROCEEDINGS

OF

THE ROYAL SOCIETY OF TASMANIA

FOR THE YEAR

1938

Edited by

JOSEPH PEARSON, D.Sc. (Manc.), D.Sc. (Liverpool), F.R.S.E., F.L.S.

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Australian Leaf-Hoppers (Homoptera, Jassoidea)

Part VIII

By

J. W. Evans, M.A., F.R.E.S.

In the present paper on Australian Leaf-Hoppers, the following families are dealt with: Cicadellidae, Nirvaniidae, Euacanthidae, and the Euscelidae, in part. In addition, notes are given on the Paropiidae, Pythamidae, Jassidae, and Eupterygidae.

The purpose of this and of preceding papers has been to collect together references scattered in numerous periodicals extending over a century, to revise the classification where necessary, to enable students to obtain some idea of the jassoid fauna of the continent, and, primarily, to render it possible for entomologists other than specialists in the group, to place in their correct families and genera the commoner representatives of this super-family which are taken in general collecting.

To date 421 species, 66 of which are believed to be synonyms, contained in 108 genera, 79 of which are peculiar to the region, have been described from Australia. It is probable that approximately three-quarters of the available genera have been defined, but it is unlikely that more than one-half of the Australian species have yet been described.

CICADELLIDAE

The Cicadellidae, which are poorly represented in Australia, are of world-wide distribution, being especially abundant in South America. All the Australian species are placed in the type genus, since, although they might well be separated into three genera, such a course would be unwise without a knowledge of foreign forms.

Cicadella Latreille

Cuvier's Régne Animal, III.; 406, 1817.

Genotype **Tetigonia viridis** L.

This genus comprises cylindrically-shaped insects that have the fronto-clypeus swollen and extending on to the crown of the head. The ocelli are dorsal in position and occur at the apices of the frontal sutures, and there is no suture present between the fronto-clypeus and the vertex. The pronotum is broad and the propleurae widely separate the eyes from the bases of the tegmina. The tegmina are long and narrow, the venation is frequently obscure, and the appendices, which are narrow, extend to the apices of the tegmina. The hind tibiae have three rows of long spines with or without minute spines between each of the stoutest spines, and the male genitalia have broad pygophores with or without processes, and parameres that are much shorter than the sub-genital plates.

Ten species have been described previously from Australia and one South African species incorrectly recorded from Australia. Of the named species, four are unknown to me, one is a synonym, and *C. parthaon* Kirk. has been figured previously. The remaining species are figured, and in addition six new species are described below.

Cicadella coerulescens (Fabr.)

Cicada coerulescens F., 1803, Syst. Rhyng. 74.
Aulacizes dives Walk., 1851, List Homopt. III.; 791.
Tettigonia coerulescens Sign., 1853, Ann. Soc. Ent. Fr. (3) 1; 672.

Kirkaldy (1907) has suggested that the above species does not belong to this genus.

Cicadella quadrata (Walk.)

Tettigonia quadrata Walk., 1851, List Homopt. III., 781.

Cicadella perkinsi (Kirk.)

Tetigonia perkinsi Kirk., 1906. Hawaii Sug. Ass. Bull. 1 (9); 319.

Cicadella latromarginata (Dist.)

Tetigoniella latromarginata Dist., 1917, Ann. Mag. Nat. Hist. 20; 190.

Cicadella albomarginata (Sign.) (Plate I, fig. 5)

Tettigonia albomarginata Sign., 1853, Ann. Soc. Ent. Fr. (3) 1; 347.
Tetigonia pettimolua Kirk., 1906, Hawaii Sug. Ass. Bull. 1 (9); 362.

Cicadella koebelei (Kirk.) (Plate I, figs. 3a-d)

Tetigonia koebelei Kirk., 1906, Hawaii Sug. Ass. Bull. 1 (9); 319.

Cicadella pasiphae (Kirk.) (Plate I, figs. 1a-d)

Tetigonia pasiphae Kirk., 1906, Hawaii Sug. Ass. Bull. 1 (9); 320.

Cicadella parthaon (Kirk.)

Tetigonia parthaon Kirk., 1906, Hawaii Sug. Ass. Bull. 1 (9); 321.

Cicadella richmondensis (Dist.) (Plate I, fig. 11)

Tetigoniella richmondensis Dist., 1917, Ann. Mag. Nat. Hist. 20; 190.

Cicadella albida (Walk.)

Tettigonia albida Walk., 1851, List Homopt. III., 767.

The last named species was originally described from South Africa, and later recorded from India and Australia by Signoret (1853), and Kirkaldy (1906). In 1907 Distant pointed out that the Oriental species was distinct from the African one and proposed the new name *spectra* Dist. for the Oriental species. Mr. China has informed me that neither of these species are represented in the Australian fauna.

Cicadella angustata, sp. nov.

(Plate I, figs. 2, 10)

Length, 8 mm. *Head*, facially pale yellowish-brown, with a central dark-brown stripe on the fronto-clypeus, and with a series of narrow transverse brown stripes laterally. Crown of head and *pronotum* pale yellowish-brown, with dark-brown markings. *Scutellum*, marked with a pattern of dark-brown and yellowish-brown. *Tegmen*, hyaline-brown or dark greenish-black, the costal border narrowly white; venation indistinct. *Thorax* and *abdomen*, ventral surface ochreous.

Type ♂, from National Park, Queensland (coll. H. Hacker), in the collection of the Queensland Museum.

Cicadella heroni, sp. nov.

(Plate I, fig. 7)

Length, 8 mm. *Head*, facially egg-yellow, with two wide brown longitudinal stripes on the fronto-clypeus. Crown of head, *pronotum*, and *scutellum*, yellow, with brown markings. *Tegmen*, dull metallic green, the costal border white; venation indistinct. *Thorax* and *abdomen*, ventral surface, pale yellow.

Type ♀, from Ulong, East Dorrigo, New South Wales (Coll. W. Heron), in the collection of the Australian Museum, Sydney.

Cicadella naomiae, sp. nov.

(Plate I, fig. 9)

Length, 6 mm. *Head*, facially pale lemon-yellow, the ante-clypeus with a broad median longitudinal brown stripe, and the fronto-clypeus with two indistinct lateral stripes; antennal pits, deep. Crown of head, *pronotum*, and *scutellum*, yellow with black markings. *Tegmen*, dull bronze, costal border narrowly black fringed with white; veins with minute raised dots. *Thorax* and *abdomen*, ventral surface pale yellow. *Legs*, pale brown.

Type ♂, from Seven Mile Beach, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Cicadella sidnica, sp. nov.

(Plate I, fig. 12)

Length, 6 mm. *Head,* ventral surface with the ante-clypeus and fronto-clypeus black medially; the black area widens posteriorly and extends across the head above the antennal ledges; rest of the facial surface of the head yellow, but for a narrow dull-brown area in the centre of the fronto-clypeus anteriorly. Crown of head and *pronotum* marked with a pattern of yellow and black. *Scutellum,* black, the apex brown. *Tegmen,* greenish black, the costal border hyaline-brown. *Thorax* and *abdomen,* ventral surface, yellow. *Legs,* pale yellowish-brown, spines on the hind tibiae dark brown and black.

Type ♂, from Sydney New South Wales (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Cicadella markei, sp. nov.

(Plate I, figs. 4, 8)

Length, 7 mm. *Head,* ventral surface ochreous, with or without a broad median stripe on the ante-clypeus, and two brown stripes on the fronto-clypeus. Crown of head and *pronotum,* bright ochreous yellow with black markings. *Scutellum,* ochreous, with the anterior angles black. *Tegmen,* black; costal margin narrowly black, with a broad yellowish-green stripe posterior to the black border. *Thorax* and *abdomen,* ventral surface ochreous. *Legs,* very pale brown, spines somewhat darker brown.

Type ♂, from Dover, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Cicadella dianae, sp. nov.

(Plate I, fig. 6)

Length, 8 mm. *Head,* ventral surface brownish-yellow, with markings similar to those described for *C. markei.* Crown of head and *pronotum,* pale brownish-yellow, with black markings. *Scutellum,* sordid yellow, anterior angles black. *Tegmen,* black, apically brownish-grey. *Thorax* and *abdomen,* ventral surface, and legs, sordid yellow.

Type ♀, from National Park, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

NIRVANIIDAE.

The Nirvaniidae, which have their headquarters in the Oriental region, are poorly represented in Australia. In a key to the various jassoid families given by Baker (1923), they are defined as leaf-hoppers, in which the upper margin of the face is not extended beyond the margin of the vertex and not visible in dorsal view, or only a little just in front of the eyes. The ocelli are on the anterolateral

border of the head, or just above or below it, the lorae are small and narrow, and the antennae are usually inserted distinctly above the eyes in facial view, rarely on the upper line of, or between, the eyes, in which case the head is produced. The tegmina are usually without ante-apical cells, and the venation is seldom distinct basally.

Only one insect belonging to this family has previously been described from Australia. This species, *Macroceratogonia aurea* Kirk. was considered by Kirkaldy (1906) to be an aberrant Cicadellid. but has been placed by Baker in the Macroceratogoniinae, one of the three subfamilies of the Nirvaniidae. Three new species are described below, all belonging to genera that are included in the Nirvaniinae. Baker has pointed out that the descriptions of *Nirvana* Kirk. and *Ophiuchus* Dist. are inadequate, hence it is possible that the species placed in these genera may not be congeneric with the genotypes. They do appear to be congeneric with the species described by Baker, which he attributed to these genera.

Nirvana Kirkaldy

Entomologist 33: 293, 1910.

Genotype **Nirvana pseudommatos**, Kirk.

Baker, in his key to the genera of the Nirvaniinae, states that species in the genus *Nirvana* have the 'front' depressed only apically. Although the species described below has the 'front' evenly convex, it would appear to be congeneric with those described by Baker.

Nirvana adelaideae, sp. nov.

(Plate II, fig. 2)

Length, 6 mm. *Head*, ventral surface greenish-yellow, with two median black spots at the posterior apex; maxillary plates narrow; antennae long, antennal pits distinct, but not deep. Fronto-clypeus evenly convex, with a median carina posteriorly. Margin of head with an ill-defined carina that separates the fronto-clypeus from the vertex. Dorsal surface of head greenish-yellow, with a median black stripe that extends posteriorly onto the thorax. Crown convex; ocelli equally visible in dorsal and lateral aspects. *Pronotum*, collar-like, almost parallel-sided. *Tegmen*, hyaline, partially suffused with yellowish-brown, with an ante-apical hyaline-white fascia and a small brown marking at each end of the fascia. *Thorax*, ventral surface, yellow. *Legs*, pale green, but for the hind femora, which are yellow, and the tarsal claws, which are dark brown. Hind tibia, with three rows of long spines and with a few minute spines set between the most widely-spaced spines. *Abdomen*, ventral surface, yellowish-green; ovipositor sheath spinous.

Type ♀, from Waterfall Gully, Adelaide, South Australia (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Kana Distant

Faun. Brit. India, Rhynch. 4, 285, 1908.

Genotype **Kana thoracica** Dist.

Kana dorrigensis, sp. nov.

(Plate II, figs. 1 a-b)

Length, 6 mm. *Head*, ventral surface, pale whitish-yellow; maxillary plates, wide; antennae, short, antennal pits, deep, close to the posterior apex of the head; fronto-clypeus, concave. Apical border of head wider against the eyes than in the centre; crown separated from the fronto-clypeus by a distinct carina. Crown of head, with three orange longitudinal stripes and two white stripes that continue onto the pronotum, blunt apically, and very slightly concave, so that the ocelli are visible laterally as well as dorsally. *Pronotum* not parallel-sided: both the head and pronotum are slightly declivous. *Tegmen*, pale orange-brown, with a row of black, white, orange, and white markings against the costal border close to the apex, and a diffuse black marking in both the apical median and cubital cells. *Thorax* and *abdomen*, ventral surface, yellowish-white.

Type ♀, from Dorrigo, New South Wales, in the collection of the South Australian Museum.

Ophiuchus Distant

Faun. Brit. India, Rhynch. 7, 334: 1918.

Genotype **Ophiuchus princeps** Dist.

Ophiuchus pallidus, sp. nov.

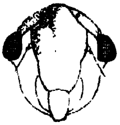
(Plate II, fig. 3)

Length, 6 mm. General coloration pale yellowish-white. *Head*, ventral surface, maxillary plates wide, fronto-clypeus convex anteriorly, concave posteriorly; antennae long. Apex of head flattened, of even width throughout, apical carina distinct. Crown of head spatulate, anteriorly flat, posteriorly inclined; ocelli only visible dorsally. *Tegmen*, milky-white, venation distinct.

Type ♀, from Stewart River, Queensland (coll. Hale and Tindale), in the collection of the South Australian Museum.

EUPTERYGIDAE

A list of the described Australian Eupterygidae was published by Myers in 1928, and since that date no new species have been added. Dumbleton (1934) has shown that *Typhlocyba froggatti* Baker (*australis* Froggatt) is an introduced European species, and not a member of the indigenous fauna. Only fifteen species have been described from Australia, but the family is well represented here. The difficulty experienced in deciding whether a species is indigenous or introduced, together with the involved synonymy, has acted as a deterrent to the description of new species. However, their increasing importance as suspected vectors of virus diseases, and the recent publication of Ribaut (1937), should serve to awaken interest in this group.



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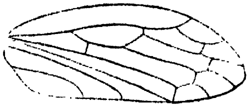

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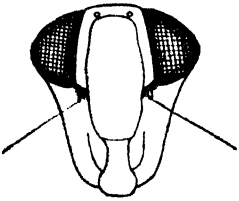
Fig. 1.—*Megopthalmus scanicus*, head.
Fig. 2.—*Megopthalmus scanicus*, tegmen.

PAROPIIDAE

Only one genus, represented by a single species, has been described from Australia. This species, *Kahavalu gemma* Kirk., has been adequately described by Kirkaldy (1906). The Paropiidae may be recognized by their characteristic deep thimble pitting sculpture. The ocelli lie in deep grooves at the apical margin of the head, and the hind tibiae have a few small spines and hairs on the apical half. To enable the recognition of members of this family, figures are given of a European representative, *Megopthalmus scanicus* Fall., no specimens of *K. gemma* being available to the author.

JASSIDAE

Tharra labena Kirk. (1906) is the sole representative of this family so far described from Australia. Kirkaldy suggested that his genus *Tharra* was possibly only a group of *Jassus* Fabr. No specimens of *T. labena* being available for study, figures are given of *Jassus indicus* Walk. and *Jassus olitorius* Say.



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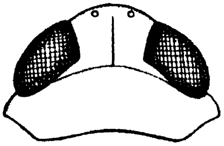

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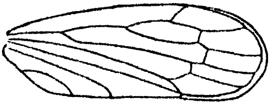

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Fig. 3.—*Jassus indicus*, head.
Fig. 4.—*Jassus olitorius*, head and prothorax.
Fig. 5.—*J. olitorius*, tegmen.

PYTHAMIDAE

Baker has included two of Kirkaldy's genera, each represented by a single species in this family. These are *Dryadomorpha pallida* Kirk. (1906) and *Tortor daulias* Kirk. (1907). Kirkaldy has figured the former (Plate 32, figs. 12-14). According to Baker, in all the genera of this family the pronotum is truncate or slightly incurved posteriorly; the anterolateral carinae of the vertex reach the apex, or nearly so; the sides of the front are very shallowly sinuate opposite the antennal scrobes, and the clypeus is strongly narrowed apically.

EUACANTHIDAE

The leaf-hoppers described below are the first members of this family to be described from Australia. They have superficial characters in common with both the Cicadellidae and the Euscelidae.

Euacanthella, gen. nov.

The head is arrow-shaped, the ante-clypeus much narrower anteriorly than posteriorly, the antennal scrobes distinct, but short, and the antennal pits deep. The crown of the head, which is slightly tilted dorsally at the apex, has a slight depression anteriorly, has always a coronal suture, and may have a transverse epicranial suture. The ocelli are on the crown, well away from the anterior margin. The pronotum is much narrower than the head, including the eyes, and the propleurae narrowly separate the eyes from the bases of the tegmina. The scutellum is small. Both brachypterous and fully-winged forms occur, and the tegmina of the winged forms are narrow.

Euacanthella palustris, sp. nov. (Genotype)

(Plate III, figs. 8 a-c)

Length, 8 mm. *Head*, ventrally black, mottled sparsely with pale brown; eyes, pale brown. Crown produced anteriorly, dark brown, mottled with yellowish-brown. Anterior third of crown divided from the posterior two-thirds by a transverse ridge. *Pronotum* concolorous with the crown. *Scutellum*, dark brown, with two more or less oval yellow markings. *Tegmen* reaching as far as the first abdominal segment; wings not developed. *Thorax* and *abdomen* and *legs*, very dark brown, mottled with pale brown.

Type ♀, from Snug, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Euacanthella insularis, sp. nov.

(Plate III, figs. 9 a-b)

Length, 8 mm. *Head*, pale yellow, suffused with an irregular pale brown pattern; on the crown an indistinct transverse ridge. *Pronotum*, concolorous with the head. *Scutellum*, yellow. *Tegmen*, short, as with *E. palustris*; wings not developed. *Thorax, abdomen* and *legs*, pale yellow with a faint irregular pattern of very pale brown. *Male Genitalia*, with a long, narrow process arising from the base of the ventral surface of the pygophore, and a short hooked-shaped process arising from the dorsal surface of the pygophore.

Type ♂, from Hobart, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Euacanthella bicolor, sp. nov.

(Plate III, figs. 10 a-c)

Length, 5·5 mm. *Head*, ventrally, brown mottled with yellowish-brown, crown slightly paler in colour. *Pronotum*, concolorous with the crown. *Tegmen*, fully developed, pale hyaline-brown, veins, white, wings developed. *Thorax* and *abdomen*, ventral surface white, mottled with grey. Fore and middle *legs* pale brown; hind legs white, spurs brown. *Male Genitalia*, with a long process arising from the base of the pygophore.

Type ♂, from Snug, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

EUSCELIDAE

In previous papers (Evans, 1936, a, b) the arboreal Australian Euscelidae have been described, and one tribe, the Paradorydiini, of the sub-family Eupelicinae. The remaining representatives of the family are largely confined to grasses, and are especially abundant in swamp environments.

Representatives of fifteen genera have previously been described from Australia; four new ones are described below. Of these, ten are apparently confined to the Australian region.

EUPELICINAE

The genus defined below is provisionally placed in the Eupelicinae, but its affinities are doubtful.

Euprora, gen. nov.

The head is produced, narrowing anteriorly and the ocelli are marginal, slightly in front of the eyes. On the crown of the head are ill-defined carinae, that extend from the ocelli in an anterior direction, and meet in a mid-line slightly posterior to the apex of the head. The pronotum is flat, on a plane with the crown of the head, and the propleurae narrowly separate the eyes from the bases of the tegmina. The tegmina are long and narrow, taper posteriorly, and extend well beyond the apices of the abdomen. The hind tibiae have three rows of spines; those of one row are set on enlarged bases, and are separated from each other by a few minute spines.

Euprora mullensis, sp. nov.

(Plate II., figs. 8 a-c)

Length, 11 mm. General coloration, pale yellowish-brown. *Head*, with longitudinal striations; eyes, reddish-brown. *Tegmen*, hyaline, tibiae, with the bases of the row of largest spines, black.

Type ♀, from Mullewa, Western Australia (coll. F. May), in the collection of the South Australian Museum.

EUSCELINAE

HECALINI

Reuteriella Signoret

Reuteria Sign., 1879, Ann. Soc. Ent. Fr. IX.; 51 (preoccupied).
Reuteriella Sign., 1880, Ann. Soc. Ent. Fr. X.; 45.

This genus, which is re-described below, superficially resembles *Selenocephalus* Germ.

The ventral surface of the head is almost flat and the lorae are small, not nearly reaching to the anterior margin of the head. The antennal scrobes are raised into a distinct ridge that extends from the margin of the head on each side, just posterior to the eyes, to beyond the apex of the clypeal suture. The head is flattened apically into a narrow flat rim, which is more or less at right-angles to the dorsal and ventral surfaces of the head. The ocelli are situated on this rim at a short distance in front of the eyes. The crown of the head, which is produced, is flat or slightly transversely concave. The pronotum widens posteriorly, and the propleurae widely separate the eyes from the bases of the tegmina. The tegmina, which overlap posteriorly, have wide appendices, and the hind tibiae, which are flattened, lack minute spines set between each of the largest spines.

Reuteriella flavescens Sign. (Genotype)

(Plate II., figs. 4 a-b)

Ann. Soc. Ent. Fr. X; 365, 1880.

Reuteriella hobartensis, sp. nov.

(Plate II., figs. 5a, b)

Length, 6·5 mm. *Head*, pale lemon-yellow, rounded anteriorly; eyes, dark brown. *Pronotum*, anterior two-thirds yellow, posterior third, and *scutellum*, pale brown. *Tegmen*, hyaline, costal border, pale yellow, the remainder pale yellowish-brown. *Thorax* and *abdomen*, ventral surface and *legs*, pale yellow.

Type ♀, from Hobart, Tasmania (coll J.W.E.), in the collection of the Australian Museum, Sydney.

Hecalus Stål

Ann. Soc. Ent. Fr. (4) IV.; 65, 1864.

Two species belonging to this genus have been described previously from Australia. These are *Hecalus pallescens* Stål (1864), which has been figured by Signoret (1879), and *H. immaculata* Kirk. (1906), which is a brachypterous form. Two new species are described below.

Hecalus basedowi, sp. nov.

(Plate II., figs. 6a, b)

Length, 9 mm. General coloration evenly yellowish-white, eyes, pale brown. *Head*, ventral surface convex, apically foliaceous. Crown spatulate, widely rounded apically. *Tegmina*, fully developed, overlapping slightly apically, and extending almost to the apex of the abdomen; appendix wide.

Type ♀, from Western Australia (coll. H. Basedow), in the collection of the Australian Museum, Sydney.

Hecalus elongatus, sp. nov.

(Plate II., fig. 7)

Length, 10 mm. General coloration yellowish-green, eyes, red. This species differs from the preceding in that the head is more spatulate, narrower apically, and produced further anteriorly.

Type ♀, from Western Australia (coll. H. Basedow), in the collection of the Australian Museum, Sydney.

XESTOCEPHALINI

Xestocephalus Van Duzee

Xestocephalus Van Duzee, 1894, Bull. Buff. Soc. Nat. Sci. 5; 197.
Myrmecophryne Kirkaldy, Hawaii Sug. Ass. Bull. 1 (9); 461.

A comparison of a paratype of *Myrmecophryne formiceticola* Kirk. with *Xestocephalus pulicarius* Van D. has shown that the two species are congeneric. Two other species belonging to this genus have been described previously from Australia, these are *X. australiensis* Kirk. and *X. sidnicus* Kirk. (1907). One new species is described below.

Xestocephalus tasmaniensis, sp. nov.

(Plate II, fig. 9)

Length, 2 mm. *Head,* ventral surface reddish-brown, palest posteriorly; antennae very long; crown, declivous, rounded apically, reddish-brown with yellow markings; ocelli marginal, visible dorsally, large and white. *Tegmen,* pale yellowish-brown, with brown areas surrounding oval hyaline spots. *Thorax,* ventral surface chocolate-brown. *Abdomen,* ventral surface brown, the hind border of each segment white.

Type *x* , from Hobart, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

EUSCELINI

Tasmanotettix, gen. nov.

The ventral surface of the head is evenly convexly rounded, the antennal pits are shallow, and the antennae long. The internal margins of the eyes lie close to the frontal suture on each side, and, apically, the head lacks a flattened margin. The ocelli are visible in dorsal aspect and lie close to, but not touching, the eyes, and the width of the crown is less than the width of each eye. The anterior margin of the pronotum is evenly rounded, and the propleurae are narrow. The tegmina, which are long and narrow, extend well beyond the apex of the abdomen. The hind tibiae are flattened, and the small spines, which are set between the bases of the largest spines, are distinct and numerous.

Tasmanotettix maculata, sp. nov. (Genotype)

(Plate III, fig. 1)

Length, 6 mm. *Head,* ventrally, very dark brown, but for the fronto-clypeus and the edges of the lorae, which are somewhat paler. Crown, mottled, with a regular pattern of dark brown, pale coffee-brown and yellow; ocelli, red. *Pronotum,* black, with six small white areas lying transversely against the anterior border, posteriorly flecked with yellowish-grey. *Scutellum*, brown with four white markings. *Tegmen*, dark brown, with hyaline-white oval, and irregularly-shaped areas; veins, dark brown, bordered with yellowish-brown. *Thorax* and *abdomen*, ventral surface black, each abdominal segment narrowly edged with white posteriorly. *Legs*, dark brown, the hind tibiae ornamented with pale and dark-brown spots.

Type ♀, from Hobart, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Diemoides, gen. nov.

The ventral surface of the head is evenly convexly rounded, the antennal pits are shallow, and the apical margin of the head is broad. The ocelli, which are on the upper border of the apical margin, are well in front of the eyes, but closer to the eyes on each side than to each other. The dorsal surface of the head is arrow-shaped, the coronal suture is distinct, and the width of the crown is greater than that of the eyes. The pronotum, of which the anterior margin is almost straight between the eyes, is narrow laterally, and the propleurae separate the eyes from the bases of the tegmina. The tegmina have narrow appendices and the anal veins are fused medially. The hind tibiae have a few very minute spines set between the bases of each of the largest spines.

Diemoides smithtoniensis, sp. nov. (Genotype)

(Plate III, fig. 4)

Length, 4 mm. *Head*, ventrally, pale brown, apical margin with three black and two white transverse stripes; ocelli, red. Crown, white suffused with pink medially. *Pronotum*, bright red anteriorly, grey posteriorly. *Scutellum*, with the anterior angles red, the remainder white. *Tegmen*, hyaline, with brown areas between the veins and the costal margin partly white; border of tegmen and anal veins red, other veins brown. *Thorax* and *abdomen*, ventral surface black with white markings. *Legs*, white with black markings.

Type ♀, from Smithton, Tasmania (coll J.W.E.), in the collection of the Australian Museum, Sydney.

Eutettix Van Duzee

Trans. Amer. Ent. Soc. 19; 302, 1892.

One species (*melaleucae* Kirk., 1907), belonging to this genus, has been described previously from Australia, and a widely distributed species, *sellata* (Uhler) (Kirkaldy, 1906), has been recorded from Queensland. Three new species are described below. The figures render unnecessary a re-description of this genus.

Eutettix norrisi, sp. nov.

(Plate III, figs. 2 a-d)

Length, 6 mm. *Head,* ventral surface, pale biscuit-colour; muscle impressions on the fronto-clypeus dark brown; eyes very dark brown. Crown of head slightly wider in the middle than against the eyes, with a median black transverse stripe just posterior to the ocelli, which, although marginal, are visible in dorsal aspect. *Pronotum,* pale greyish-brown, with a few dark-brown spots. *Scutellum,* pale yellow. *Tegmen,* transparent, veins dark brown, anal border dark brown, appendix wide. *Thorax* and *abdomen,* ventral surface, yellowish-white with a few irregular dark-brown markings. Hind tibiae, with four rows of spines and with minute spines set between the bases of each of the largest spines.

Type ♂, from Crawley, Western Australia (coll. K. R. Norris), in the collection of the Australian Museum, Sydney.

Eutettix pallida, sp. nov.

(Plate III, fig. 3)

Length, 6 mm. *Head,* ventral surface pale yellow or brown; muscle impressions paler in colour than the rest of the fronto-clypeus; eyes dark brown. Crown slightly wider in the middle than against the eyes, with a pale dark brown transverse stripe. *Pronotum,* pale yellowish-brown. *Scutellum,* yellow. *Tegmen,* including the veins, transparent. *Thorax* and *abdomen,* ventral surface pale yellow.

Type ♀, from Stewart River, Queensland (coll Hale and Tindale), in the collection of the South Australian Museum.

Eutettix selbyi, sp. nov.

Length, 7 mm. *Head,* ventral surface, pale whitish-yellow, but for the eyes, which are red, the ante-clypeus, fronto-clypeus anteriorly, and the muscle impressions, which are coffee-coloured, and two transverse black markings on the fronto-clypeus posteriorly. Crown of head, pale yellow, with two pairs of transverse black markings that do not reach as far as the eyes laterally, nor as far as the coronal suture medially, nearly as wide against the eyes as in the middle; ocelli marginal, visible in dorsal aspect. *Pronotum,* grey, with three small dark-brown markings lying behind each eye. *Scutellum,* yellowish-grey, with a dark brown V-shaped marking close to each anterior angle. *Tegmen,* white, brown apically, and with brown areas between the veins; veins dark brown. *Thorax* and *abdomen,* ventral surface, and *legs* marked with a pattern in yellow, pale and dark brown. Ovipositor sheath in the female, dark brown with white spines.

Type ♀, from Mutchilba, North Queensland, in the collection of Mr. F. E. Wilson, Melbourne.

Thamnotettix Zetterstedt

Ins. Lapp. 29; 1840.

The two species described below are the first belonging to this widely distributed genus to be described from Australia.

Thamnotettix argentata, sp. nov.

(Plate III, fig. 5)

Length, 3·5 mm. *Head*, pale yellow, marked with an irregular dark-brown pattern; eyes, dark brown. *Pronotum*, anterior, third pale yellow, posterior, two-thirds grey, flecked with transverse dark-brown markings. *Scutellum*, yellow, but for the apex, which is dark brown. *Tegmen*, hyaline, with a silvery appearance, due to the sheen of the underlying wings, patterned with an irregular network of dark-brown markings. *Thorax* and *abdomen*, ventral surface, pale yellow with scattered dark-brown markings.

Type ♂, from Burnley, Victoria (coll. J.W.E.), in the collection of the Australian Museum, Sydney

Thamnotettix canberrensis, sp. nov.

(Plate III, fig. 6)

Length, 3 mm. General coloration pale yellow, eyes, dark brown, ocelli, red. *Head*, very pale yellow, crown much wider medially than against the eyes. *Pronotum* and *scutellum*, apricot yellow. *Tegmen*, hyaline-yellowish, extending beyond the apex of the abdomen.

Type ♀, from Canberra, F.C.T. (coll J.W.E.), in the collection of the Australian Museum, Sydney.

Phrynophyes Kirkaldy

Hawaii Sug. Ass. Bull. 1 (9); 327, 1906.

Two species of this genus, *phyrnophyes* Kirk. and *parvula* Kirk., have been described previously from Australia. The figures given by Kirkaldy make re-description of this genus unnecessary.

Phrynophyes kirkaldyi, sp. nov.

(Plate III, figs. 7a-c)

Length (♀), 5 mm. General coloration, when alive, metallic green. *Head*, ventral surface, pale yellowish-brown; muscle impressions on the fronto-clypeus transverse, brown; eyes, dark green. Crown, pale yellowish-green, pointed apically, distance between the anterior corners of the eyes greater than between the internal posterior corners; ocelli, visible in dorsal aspect, minute. *Pronotum* and *scutellum*, yellowish-green. *Tegmen*, hyaline, olive-green, costal border whitish-green, veins outlined in brown. *Thorax*, ventral surface, and legs, pale yellowish-brown with dark-brown markings. *Abdomen*, ventral surface, marked with a variable pattern of light and very dark brown. The abdomen extends well beyond the apices of the folded tegmina in the female, but only slightly beyond in the male.

Type ♂, from Snug, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Deltocephalus Burmeister

Gen. Ins. 1838.

The following six species of this cosmopolitan genus have been described previously from Australia: *flavidiventris Stål* (1859), *perparvus* Kirk. (1906), *lotis* Kirk., *polemon* Kirk., *lucindae* Kirk. (1907), *arunda* Jacobi (1909). Two new species are described below.

Deltocephalus obliquus, sp. nov.

(Plate III, figs. 11a-c)

Length, 3 mm. *Head*, ventral surface, pale reddish-brown, darkening posteriorly; muscle impressions on fronto-clypeus black, oblique; eyes, black. Crown of head pointed apically; muscle impressions visible on small semi-circular areas lying on each side of the anterior margin of the head, between these impressions, crown, black; the remainder yellow, marked with a regular pattern of light and dark brown. *Pronotum*, short, anteriorly concolorous with the crown of the head, posteriorly grey. *Scutellum*, yellow, with two round black spots. *Tegmen*, hyaline-grey, with a few irregular dark-brown markings; veins, white. *Thorax* and *abdomen*, ventral surface, pale yellowish-brown; legs somewhat darker brown.

Type ♂, from Smithton, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Deltocephalus montanus, sp. nov.

(Plate III, fig. 12)

Length, 3 mm. *Head*, ventral surface, black, mottled with bright yellow: crown only slightly pointed apically, muscle impressions not extending onto the crown, marked with an irregular pattern of black and yellow; ocelli, red. *Pronotum*, yellowish-grey, flecked with transverse dark-brown markings. *Tegmen*, hyaline, greyish-brown; veins, white bordered with irregular dark-brown markings. *Thorax* and *abdomen*, ventral surface, black. *Legs*, marked with an irregular pattern of dark brown, yellow and black.

Type ♂, from Mount Lofty, South Australia (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

NOTES.

In addition to those described in this paper, the following genera are apparently confined to Australia:—

Anemochrea Kirk., 1906; genotype *A. mitis* Kirk.
Anemolua Kirk., 1906; genotype *A. hanuala* Kirk.
Giffardia Kirk., 1906; genotype *G. dolichocephala* Kirk.
Soracte Kirk., 1907; genotype *S. appollonos* Kirk.
Thamnophryne Kirk., 1907; genotype *T. nysias* Kirk.

Whilst it is possible that *Anemochrea* and *Anemolua* are related to *Euacanthella* (Euacanthidae), the remainder, with the exception of *Giffardia*, which may be related to *Euprora*, belong to the *Euscelini*.

The following species described from Australia belong to genera that are well represented in other zoo-geographical regions: *Driotura aristarche Kirk.* (1907); (paratype examined). Kirkaldy (1906) placed the following species in the genus *Phrynomorphus* Curtis, which is a synonym of *Euscelis* Brullé: *longuinquus* Kirk., *taedius* Kirk., *hospes* Kirk., *chlorippe* Kirk.

Limnotettix Sahl. contains three Australian species, *dimittendus* Kirk. (originally placed in the genus *Euleimonios* Kirk.), *tachyporias* Kirk., and *capitatus* Kirk. *Lonatura* Osborn and Ball and *Scaphoideus* Uhler each contains a single Australian species, *L. austrina* Kirk. (1907) and *S. pristidens* Kirk. (1907). *Nephotettix* Matsumura contains two Australian species, *plebeius* Kirk. (1906) and *eurytus* Kirk. (1907). Kirkaldy suggested that *N. plebeius* is an introduced species.

BALCLUTHINAE.

The following have been described from Australia:—*Nesosteles* Kirk. (1906), genotype *N. hebe* Kirk. (from Viti Isles); Australian species, *sanguinescens* Kirk., *sordidor* Kirk., *glauca* Kirk., and *taedia* Kirk., *Pettya* Kirk. (1906), genotype *P. anemolua* Kirk.

My attention having been drawn to the fact that *Ipocerus* Evans (1934) is preoccupied by *Ipocerus* Baker, type *Ipocerus kirkaldyi* (1915), the name of the former genus is hereby changed to *Bakeriola*, type *Bakeriola procurrens* (Jacobi).

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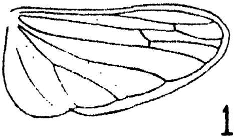
PLATE I

Fig. 1a.—*Cicadella pasiphae*, wing.
Fig. 1b.—*Cicadella pasiphae*, tegmen.
Fig. 1c.—*Cicadella pasiphae*, head and thorax, dorsal aspect.
Fig. 1d.—*Cicadella pasiphae*, hind margin of last abdominal segment of ♀
Fig. 2.—*Cicadella angustata*, head.
Fig. 3a.—*Cicadella koebelei*, head and thorax, dorsal aspect.
Fig. 3b.—*Cicadella koebelei*, hind margin of last abdominal segment of ♀
Fig. 3c.—*Cicadella koebelei*, male genitalia.
Fig. 3d.—*Cicadella koebelei*, male genitalia.
Fig. 4.—*Cicadella markei*, hind tibia.
Fig. 5.—*Cicadella albomarginata*, head and thorax, dorsal aspect.
Fig. 6.—*Cicadella dianae*, head and thorax, dorsal aspect.
Fig. 7.—*Cicadella heroni*, head and thorax, dorsal aspect.
Fig. 8.—*Cicadella markei*, head and thorax, dorsal aspect.
Fig. 9.—*Cicadella naomiae*, head and thorax, dorsal aspect.
Fig. 10.—*Cicadella angustata*, head and thorax, dorsal aspect.
Fig. 11.—*Cicadella richmondensis*, head and thorax, dorsal aspect.
Fig. 12.—*Cicadella sidnica*, head and thorax, dorsal aspect.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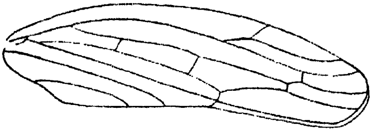
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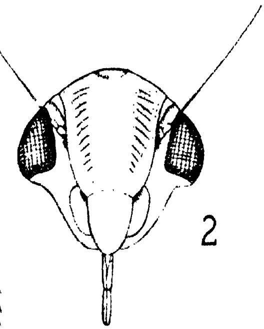
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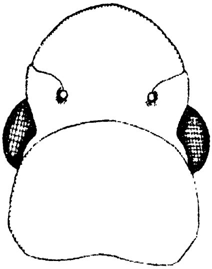
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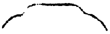
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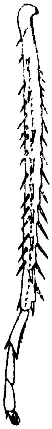
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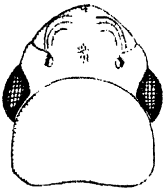
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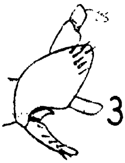
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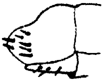
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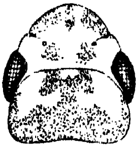
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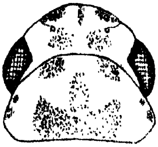
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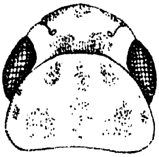
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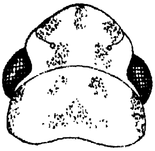
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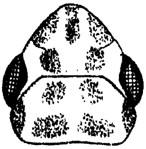
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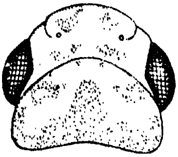
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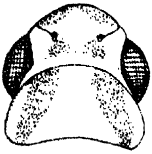
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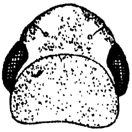
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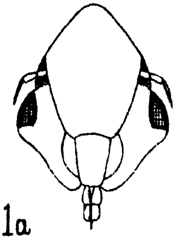
PLATE II

Fig. 1a.—*Kana dorrigensis*, head, ventral aspect.
Fig. 1b.—*Kana dorrigensis*, head and thorax, dorsal aspect.
Fig. 2.—*Nirrana adelaideae*, head and thorax, dorsal aspect.
Fig. 3.—*Ophiuchus pallidus*, tegmen.
Fig. 4a.—*Reuteriella flavescens*, hind tibia.
Fig. 4b.—*Reuteriella flavescens*, tegmen.
Fig. 4c.—*Reuteriella flavescens*, head in profile.
Fig. 4d.—*Reuteriella flavescens*, head and thorax, dorsal aspect.
Fig. 4e.—*Reuteriella flavescens*, head, ventral aspect.
Fig. 5a.—*Reuteriella hobartensis*, head, ventral aspect.
Fig. 5b.—*Reuteriella hobartensis*, head and pronotum, dorsal aspect.
Fig. 6a.—*Hecalus basedowi*, tegmen.
Fig. 6b.—*Hecalus basedowi*, head and pronotum, dorsal aspect.
Fig. 7.—*Hecalus elongatus*, head and pronotum, dorsal aspect.
Fig. 8a.—*Euprora mullensis*, head and pronotum, dorsal aspect
Fig. 8b.—*Euprora mullensis*, head and pronotum in profile.
Fig. 8c.—*Euprora mullensis*, tegmen.
Fig. 9.—*Aestocephalus tasmaniensis*, head.



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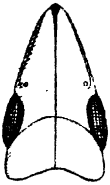

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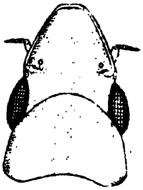

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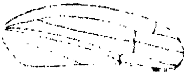

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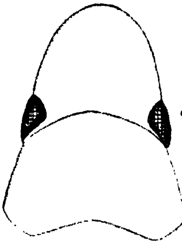

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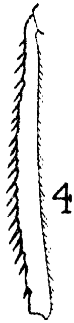

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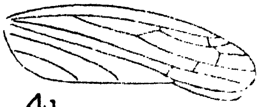

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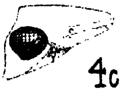

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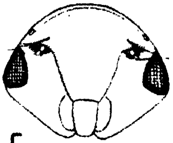

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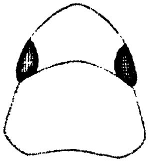

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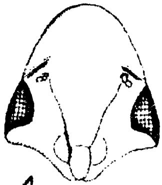

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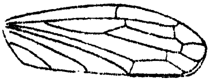

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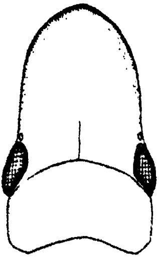

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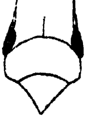

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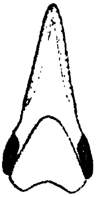

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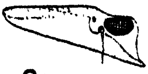

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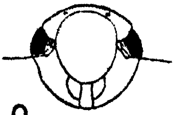

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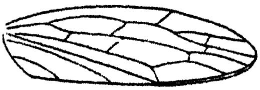

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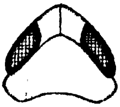
PLATE III.

Fig. 1.—*Tasmanotettix maculata*, head and pronotum, dorsal aspect.
Fig. 2a.—*Eutettix norrisi*, tegmen.
Fig. 2b.—*Eutettix norrisi*, male genitalia.
Fig. 2c.—*Eutettix norrisi*, head and thorax, dorsal aspect.
Fig. 2d.—*Eutettix norrisi*, head, ventral aspect.
Fig. 3.—*Eutettix pallida*, head and pronotum, dorsal aspect.
Fig. 4.—*Diemoides smithtoniensis*, hind tibia.
Fig. 5.—*Thamnotettix argentata*, head and thorax, dorsal aspect.
Fig. 6.—*Thamnotettix canberrensis*, tegmen.
Fig. 7a.—*Phrynophyes kirkaldyi*, head, ventral aspect.
Fig. 7b.—*Phrynophyes kirkaldyi*, head and pronotum, dorsal aspect.
Fig. 7c.—*Phrynophyes kirkaldyi*, male genitalia.
Fig. 8a.—*Euacanthella palustris*, tegmen.
Fig. 8b.—*Euacanthella palustris*, head, ventral aspect.
Fig. 8c.—*Euacanthella palustris*, head and pronotum, dorsal aspect.
Fig. 9a.—*Euacanthella insularis*, head, dorsal aspect.
Fig. 9b.—*Euacanthella insularis*, male genitalia.
Fig. 10a.—*Euacanthella bicolor*, tegmen.
Fig. 10b.—*Euacanthella bicolor*, head, dorsal aspect.
Fig. 10c.—*Euacanthella bicolor*, male genitalia.
Fig. 11a.—*Deltocephalus obliquus*, head and thorax, dorsal aspect.
Fig. 11b.—*Deltocephalus obliquus*, last ventral abdominal segment of ♀
Fig. 11c.—*Deltocephalus obliquus*, male genitalia.
Fig. 12.—*Deltocephalus montanus*, male genitalia.



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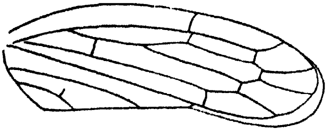

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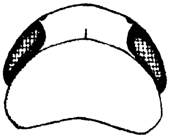

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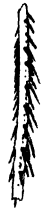

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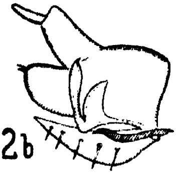

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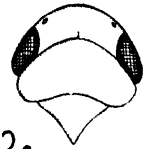

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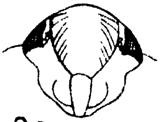

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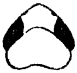

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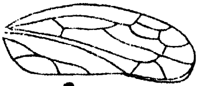

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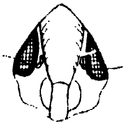

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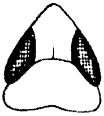

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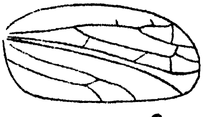

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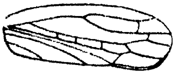

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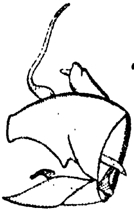

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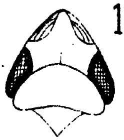

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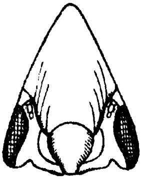

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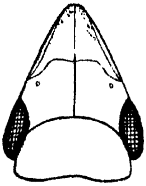

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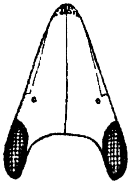

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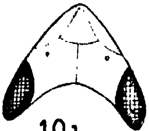

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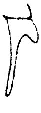

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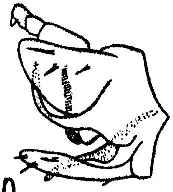

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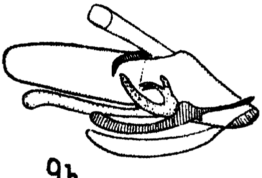

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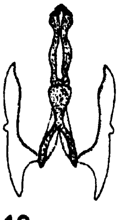

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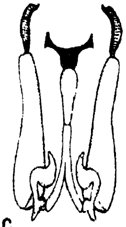

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PAP. & PROC. ROY. SOC. TASMANIA, 1938 (11TH NOVEMBER, 1938.)

19

A Contribution to the Study of the Jassoidea (Homoptera)

By

J. W. EVANS, M.A., F.R.E.S.

INTRODUCTION.

Some ten years ago a study was begun of the jassoid fauna of Australia. Since then group after group has been dealt with in turn, and, at present, it is believed that the principal divisions have been defined, although only a fraction of the actual genera and species have been described.

At an early stage of the investigation it was decided that the series of taxonomic papers should be followed by one in which not only would a key be given to the various families considered previously, but their inter-relationships would be discussed and a comparison made with the faunas of other zoo-geographical regions. The scope of the present paper, which is the final one in the series, is very different from that originally anticipated, because in recent years it has become increasingly clear that the classification adopted in the past is not a natural one. Thus, under the present classification, some families comprise genera in no way closely related to one another, and many genera with well-defined natural affinities are to be found in widely separated groups. Hence it has become necessary to rearrange the position of several genera and to discard certain of the criteria formerly used for the classification of the major groups.

This paper is concerned principally with Australian jassoids, but a few genera from other regions are included, as they assist in an understanding of the complexities involved. The number of families comprised in the Jassoidea must always remain a matter of personal opinion, as a family is an arbitrary unit. In the classification proposed it is realized that the various families are not of equal status.

Moreover there exists a number of groups of genera, representatives of which have either been unobtainable for study (e.g., *Adelungia* Mel. and related genera), or which are unknown to me, that have characteristics that are just as distinct as those considered here of sufficient importance to merit the raising of groups to family rank. Little attention is paid to divisions of lower status.

In order to assign a species to its correct family it is usually insufficient to take into account only one or two of its characters, but the insect must be regarded as a whole, and all its characteristics of structure, coloration, and sculpture examined and balanced. A key is not given, as it was found impossible to construct a concise one, but the figures should render the absence of a key unimportant.

The present writer, who is out of touch with libraries, is fully aware that he is not acquainted with all the literature concerned with jassoid classification, and that this work must be incomplete in certain respects. Nevertheless, it is believed that a study based on the leaf-hoppers of an important, though little-known, faunal zone, will be of assistance in helping to pave the way towards an understanding of some of the problems that have made the classification of this group of Homoptera one of the most complex in the whole insect kingdom.

PRESENT SYSTEMS.

So many varied systems of classification have been proposed for the jassoid complex that little purpose would be served by a general review. Instead the systems of four workers are dealt with, three of which refer to particular geographical units.

The most recent is that of Ribaut (1936), who is concerned with the European fauna, and that of France in particular. Ribaut divides the Cicadoidea into seven families, the Membracidae, Cicadidae, Cercopidae, Scaridae, Ulopidae, Jassidae, and Typhlocybidae. The last four on the list are more closely related to one another than they are to any of the first three, or than are any of the first three to one another, and, whilst it might be accepted that four families are sufficient to include the limited fauna under consideration, if the Scaridae (Ledridae) merit separation, the Jassidae are certainly in need of subdivision. Whilst the character of a pronotum with dorsal protuberances may serve to define *Ledra aurita* L., it is not one of any value when applied to the family as a whole.

DeLong (1923), who described the fauna of a single State in Eastern North America, considers the Jassoidea as a single family, the Cicadellidae, and divides them into four sub-families, the Bythoscopinae, Jassinae, Cicadellinae, and Gyponinae. The sole character made use of to define the Bythoscopinae is that the ocelli are on the front below the margin of the vertex, and the genera comprised in this family are *Agallia* Curtis, *Idiocerus* Lewis, *Macropsis* Lewis, *Oncopsis* Burm., and *Bythoscopus* Germ. The Jassinae are considered as including those leaf-hoppers that have the ocelli on the margin of the vertex, where such is definite, or on that portion of the head between the vertex and the front, where there is no perceptible limit to either. Three tribes, the Jassini, Acucephalini, and Typhlocybini are defined, and, whilst the lastnamed is separated on characters supplied by tegminal venation, the position of the ocelli is again made use of to differentiate the remaining two. Whilst only four genera are placed in the Acucephalini, twenty-five genera are comprised in the Jassini; amongst them are *Jassus* Fabr. and *Euscelis* Brullé. The Cicadellinae, which contain numerous American genera, are defined as having the ocelli on the disc of the vertex and the body cylindrical, not dorso-ventrally flattened, whilst the Gyponinae, although also having the ocelli on the disc of the vertex, have the body dorso-ventrally flattened. Three genera are placed in the Gyponinae: *Gypona* Germ., *Penthimia* Germ., and *Xerophloea* Germ.

Naudé (1926), in a memoir on the jassoid fauna of South Africa, divides the Cicadellidae into six sub-families, the Ulopinae, Ledrinae, Bythoscopinae, Cicadellinae, Gyponinae, and Jassinae, and also separates the last-named into Acucephalini, Jassini, and Typhlocybini.

The Ledrinae are defined in a key as having the hind tibiae four-cornered, usually armed with numerous spines, the eyes elliptical, more or less in line with the margin of the vertex, and the pronotum usually angularly extended laterally, whilst the Ulopinae have globular eyes standing out from the outline of the head and the pronotum rounded or straight laterally. Other points to be noted are that a genus *Pachynus* Stål, which is related to *Macropsis* occurs in South Africa, and that *Penthimia* and *Rubria* Stål are placed in the Gyponinae.

Baker (1923) presented a classification based on the fauna of the world, although he acknowledged that it did not presume to be a complete system since some of the most important anatomical features of several jassoid genera are neither described nor figured. He divided the Jassoidea into fifteen families, the Tettigonellidae (Cicadellidae), Gyponidae, Penthimiidae, Thaumatoscopidae, Ledridae, Paropiidae, Stenocotidae, Koebeliidae, Ulopidae, Signoretidae, Euacanthidae, Pythamidae, Nirvaniidae, Jassidae, and Bythoscopidae. Up to the present the author has accepted Baker's classification, although the Eupterygidae (Typhlocybidae) have been resognized as a distinct family, and following Haupt (1929), *Jassus* and related genera have been considered as a family, the Jassidae, distinct from the Euscelidae, which comprises the majority of genera usually placed in the Jassidae.

THE COMPARATIVE VALUE OF DIFFERENT MORPHOLOGICAL CHARACTERS.

The Jassoidea are defined by Imms (1925), who gives them family rank, as having 'Ocelli two, rarely absent, variable in position. Antennal flagellum composed of numerous joints. Genae dilated, the frons, lorae, and genae forming one curved surface. Pronotum never prolonged backwards Posterier coxae transverse, laterally dilated; tibiae angular, the hind pair usually seriately bristly with a double row of spines; empodia large.' This definition, whilst serving to separate the group from the Membracidae and Cercopidae, is not entirely accurate, since, with many species the frons, lorae, and genae do not form one curved surface, and the hind tibiae may be circular in outline and have more than two rows of spines.

In order to determine the inter-relationships of the various genera and groups of genera, six structural features will be reviewed in turn, and the comparative value of each estimated. The selected characters are the venation of the wing; the venation of the tegmen; the shape and armature of the hind tibia; the structure of the male genitalia; the shape of the prothorax; and the external morphology of the head.

If these six characters in a number of genera are examined in order to decide upon their relative degree of stability, it is found that the venation of the wing is the one least subject to variation, and the next most stable characteristic is the venation of the tegmen. This is because venation is not subject to change following a re-orientation of muscle stresses, and the hind wing being used solely for flight purposes, will vary less than the tegmen, which has a protective as well as a flight function. Following venation, the next most persistent characters are to be found in the basic structure of the head, and of the several factors that have to be taken into account in surveying the morphology of the head, the position of the ocelli is the most unreliable, since it is the most subject to variation. It is convenient to follow a discussion of the head by an examination of the shape of the prothorax, particular attention being paid to the propleurae. Finally come the shape and armature of the hind tibia and the structure of the male genitalia, both of which supply evidence of minor importance since they are more subject to change. Whilst there are other characteristics that could be taken into account, such as the hind tarsi, which Baker (1923) believed to be of value for taxonomic purposes, those chosen are sufficient for the present purpose.

WING VENATION.

Comstock (1918) has pointed out that the Jassoidea resemble the Membracidae in that in the wings of neither group has a transverse basal trachea been developed, and the medial trachea is a member of the costo-radial group. This primitive condition occurs also with the Plecoptera and certain cockroaches.

The nomenclature followed is that of Metcalf (1913, 17), except in respect of the first anal vein for which Tillyard's (1926) interpretation is accepted, this vein being considered as the second cubital vein. Plate IV, fig. 7, represents the wing of *Putoniessa rivularis* (Walk.), of which the venation is typical of that occurring almost universally amongst the Jassoidea, Lying well away from the costal margin is a thickened vein, consisting of the apposed sub-costal and radial veins. R_1 is not developed and the radial sector is two-branched, the branches being R_{2+3} and R_{4+5}. The media is distinct basally, and not fused with the radius; distally it has two branches M_{1+2} and M_{3+4}. The remaining veins need no comment, except that the marginal vein is formed by the united tips of the longitudinal veins. Plate IV, fig. 5, represents the wing of *Eurymeloides punctata* Sign., in which the venation is identical with that of *P. rivularis*. Apart from the Eupterygidae a number of divergences from a typical wing occur, such as those shown in Plate IV, figs. 6 and 8. In figure 6, (*Bythoscopus lanio* L.) R_{4+5} and M_{1+2} are united apically. Such a condition occurs in the related genera *Eurinoscopus* Kirk. and *Trocnada* Walk. The wing of *Tartessus fulvus* (Walk.) (fig. 8) is unusual in that the marginal vein extends onto the anal area. This feature also occurs in the related genera *Sarpestus* Spangb., *Tartessoides* Ev. and *Tartessella* Ev.

The wings of the Eupterygidae, which have been figured by Ribaut, are of interest since, with certain genera (*Typhlocyba* Germ. and *Eupteryx* Curt.), a marginal vein is not developed to link the radius and second cubitus, although present, parallel with the hind margin of the wing. It is developed in other genera (*Dikraneura* Hardy). A tendency exists in representatives of this family for the veins to unite apically, so that the radius and media may terminate as a single vein (*Typhlocyba*), as two veins (*Eupteryx*), or as three (*Dikraneura*), but never as four, as is usual in the rest of the Jassoidea.

The notation used on Plate IV is not in accordance with that adopted by Ribaut, as his sub-costal is the radius, his radius the media, and his media the first cubital.

As the venation of the wing is a stable character, it might be supposed that a comparison of a typical jassoid wing with those of related groups would supply evidence of wider affinities.

Plate IV, fig. 3, represents the wing of *Sextius virescens* Fairm. (Membracidae), which is essentially identical with the normal jassoid type, the only difference being that the sub-costal vein is incorporated in the costal border and does not lie alongside the radius. The three remaining wings figured on Plate IV all show a wide divergence from the jassoid type, the closest being that of *Aethalion reticulatum* L. (fig. 4). In this wing Sc and R are distinct basally, the former being incorporated in the costal border, the radius terminates as a single vein, and the media is two-branched.

Fig. 2 represents the wing of *Cercopis jactator* F.B.W., in which, although the radius is two-branched, the media is a single vein, and is joined to the fused radial and sub-costal veins well anterior to the base of the wing. Extreme reduction is seen in fig. 1 (*Hindola compacta* Walk., Machaerotinae, Cercopidae), in which both the radius and media are unbranched, although the sub-costa is distinct basally. It is believed that the Machaerotinae are related to the Permain Scytinopteridae, since the tegminal venation of the two groups is similar.

It is thus apparent that but little light is thrown upon the relationships of the various jassoid families from a study of wing venation; this character, however, is of use in certain cases in assisting to link genera into minor groupings, where, although no changes have taken place in the basic venation of the wing, secondary vein fusions or reductions have occurred.

As far as wider relationships are concerned, the membracid type is similar to the jassoid, and that of the Aethalionidae, although distinct, displaying specialization by reduction, is nearer to the Jassoidea and the Membracidae than to either the Cercopinae or Machaerotinae.

VENATION OF THE TEGMEN.

The tegmina of several Homoptera have been found well preserved in Palaeozoic and Mesozoic strata, hence something is known of the venation of the ancestors of recent groups, but since the present-day representatives of this sub-order are mostly confined to a limited range of food-plants, it is not to be expected that they will have any great affinity to forms that may have lived on such plants as *Glossopteris*. The Angiosperms, on which most recent jassoids feed, did not develop until Triassic times, whilst those extinct species which are best known, largely from tegminal impressions, are from rocks of Permian age.

It has been previously mentioned that the Permian Scytinopteridae show affinities to present-day Machaerotinae. Tillyard (1926), however, considered that *Permojassus australis* Till., which he placed in the Scytinopteridae, might well, on tegminal venation alone, be placed in the Jassidae, its principal difference from recent forms being that the media is three-branched and the costal space extensive. However, any idea of jassoid relationship is disposed of by the hind-wing, which has also been found.

Three Triassic tegmina have been ascribed to the Jassidae (Tillyard, 1920), *Eurymelidium australe* Till., *Mesojassus ipsviciensis* Till., and *Triassojassus proavitus* Till. As pointed out by Tillyard, the venation of *E. australe* somewhat resembles that of *Eurymela* Le P. and S.; the sub-costa is not apparent as a separate vein, the radius is unbranched, and the media has two branches, but a considerable development of cross veins occurs such as is not found in modern eurymelids, except in the costal region. In the development of the radius and the media, *Mesojassus* also resembles *Eurymela*, whilst *Triassojassus*, though having a media with three apical branches, has a radius similar to that of many present-day groups other than the Eurymelidae, its three branches apparently being R_1, R_{2+3}, and R_{4+5}.

Handlirsch (1908) figures a number of Jurassic tegmina, of which two, *Acocephalites breddini* Meunier and *Jassites punctatus* Brodie, resemble the majority of present-day groups in having a radius with two principal branches R_{2+3} and R_{4+5}, R_1 also being distinct in the latter, and with an unbranched media. Two other tegmina figured might well have belonged to primitive jassoids. These are *Homopterulum signoreti* Westwood and *Pseudodelphax pulcher* Brodie, in both of which R and M are two-branched.

Martynov (1926) has created two species, *Karrajassus crassinervus* and *Archijassus minimus* on Jurassic tegmina from Turkestan, which he placed in this family. The tegmen of the former shows relationships with *Triassojassus*, whilst *Archijassus* is only represented by a fragment.

On the scanty evidence available it would seem that true jassoids first appeared in Triassic times and are descendants of a Permian group, of which so far no representatives have come to light.

Carpenter (1933) gives a reconstruction of a hypothetical forewing of the common ancestor of Permian Homoptera. This figure is reproduced on Plate V, fig. 1, for comparison with the present author's reconstruction of the forewing of a hypothetical ancestor of recent jassoids. The principal difference between the two figures is concerned with the radius, as, although in both cases it is shown to have three branches, in fig. 1, R is two-branched and Rs single, and in fig. 2 R is single and Rs two-branched. The identification of the components of the radius in fossil impressions is made possible by the fact that R is convex and Rs concave.

According to Metcalf, the sub-costal trachea is anomalous, and may be very long, as in *Jassus*, or about half the length of the main stem, as in *Platymetopius* Burm. In only one genus, *Sarpestus* (Plate VI, fig. 8), has the sub-costal vein been noted as distinct from the costal margin, and in some species in the related genus *Tartessus* Stål it is apparent in a reduced form. The radius retains its primitive condition in a number of genera, as shown on Plate VI, in all figures but 4, 6, and 10, with which R_1 is absent, the two branches representing R_{2+3} and R_{4+5}. With other genera, for example *Kyphoctis* Kirk. (Plate V, fig. 8), several costal veinlets may be present, and it is possible that one of these may represent R_1. In *Aethalion reticulatum* (Plate V, fig. 4), and with the Eurymelidae (Plate V, figs. 3, 5, 7, 9) R_{2+3} and R_{4+5} occur as a single vein, but R_1 may be distinct, as shown on Plate V, fig. 3, which represents the nymphal tegminal pad of *Eurymelops rubrovittata* A and S.

Metcalf, referring to the tracheation, states that the media is typically two-branched and that M_{1+2} must have come to lie parallel with R_{4+5} and become gradually reduced to its usual present condition of, at the most, only a cross vein connecting the media with R_{4+5}. In the fully developed tegmen the media occurs as a single vein, except with the *Eurymelidae*, in which it forks into two principal branches. In certain genera in this family the lower branch may re-divide into M_3 and M_4 (e.g., *Cornutipo* Ev., Plate V, fig. 7), whilst with others all four branches may be distinct, as is shown in the figure of the tegmen of *Pogonoscopus lenis* (Jac.) given by China (1926). The first cubitus is almost invariably two-branched, but, as shown in Plate V, fig. 8 *(Kyphoctis)* and fig. 4 *(Aethalion)*, secondary veinlets may be developed at its apex. The second cubitus lies along or close to the claval suture and connects with the margin of the tegmen. The only departure from the normal that occurs in the anal area is that a Y-vein may be formed. This probably originates in a cross-vein first connecting the two anal veins, followed by the second anal vein terminating at the cross-vein instead of extending to the anal border. Such a Y-vein is found in all the Australian Stenocotidae and in a number of genera in other families. It is also present in all the Fulgoroidea, and occurred in the Mesozoic Ipsviciidae.

Plate V, fig. 6, represents the tegmen of *Paradorydium menalus* Kirk., in which the radius appears to be a single vein, and the media seems to have two branches. Actually the reverse position occurs, the elongation of the tegmen having drawn out the cross-vein that represents all that is left of M_{1+2}.

Plate V, fig. 10, represents the tegmen of *Idiocerus seckeri* Ev., which is similar to all other Australian species that have been placed in this genus, but differs from European representatives, which have normal complete venation as far as the radius is concerned.

On major differences in the venation of the tegmen the Jassoidea can be separated into three distinct groups, the Aethalionidae, in which both the radius and the media are unbranched; the Eurymelidae, in which R_{2+3} and R_{4+5} are represented by a single vein, and the media always has two principal, and may have three or four subsidiary, branches; and the rest of the Jassoidea, in which the radius has at least two branches, and the media is either unbranched or has one branch reduced to a cross-vein. Apart from the presence or absence of R_1, the development of cross veins, the extent of the appendix and the partial fusion of adjacent veins, the venation of the tegmina of the third group of the Jassoidea, is remarkably uniform. Such differences as do occur are only of use when considered in conjunction with other characters for separating minor groups.

THE HEAD.

It is quite certain that the most reliable criteria for the determination of the inter-relationships between various jassoid groups are to be obtained from a study of head structure. This has, to a certain extent, been recognized in the past, since the usual divisions of the Jassoidea into families and sub-families have been based upon a cephalic character, the position of the ocelli. The choice of this character is an unfortunate one as it is unreliable, hence genera which are clearly related on other grounds may have species in which the ocelli are ventral, marginal, or dorsal. On the other hand, genera that have no other common characteristic have been placed in the same family merely because of the similar position of the ocelli.

The forerunners of present-day leaf-hoppers probably had opisthognathous heads with two distinct median sclerites, the clypeus, and the frons. The hind margin of the frons lay well away from the hind margin of the head, and the paired ocelli were situated close to the posterior corners of the frons. The dilator muscles of the sucking-pump were attached to the posterior half of the clypeus, which was wider than the anterior half. The sutures that bounded these sclerites, and which have been discussed in an earlier paper (Evans, 1938), were the clypeal suture, that extended from the point where the two divisions of the clypeus met, and terminated close to the antennae; the frontal suture that lay between each antenna and the ocellus, and the Y-shaped epicranial suture that lay along the posterior margin of the frons. Separating the clypeus from the frons was the transverse epistomal suture, and dividing the vertex, which must have been entirely ventral in position, was the coronal suture. A sub-genal suture was also present. Changes from such a type have taken place in several directions, the first, and almost universal change being the fusion of the frons and the clypeus and the disappearance of the epistomal suture. This was brought about by the gradual backward migration of the dilator muscles of the sucking-pump. Accompanying the disappearance of the epistomal suture the development of a transverse suture took place, separating the clypeus into two parts, an ante- and post-clypeus. This suture connects the apices of the clypeal sutures.

In certain groups, not only has the epistomal suture been obliterated, but no trace remains of an epicranial suture. This backward development of the fronto-clypeus has been accompanied by a shifting of the ocelli, which thus came to lie at the margin of the head. In other groups the head is now in two or even three planes, and, in some, the posterior third or less of the fronto-clypeus has become dorsal in position, forming with the vertex the crown of the head.

The ocelli have moved onto the crown of the head in three distinct ways. In some cases they have retained their position close to the junction of the frontal and epicranial sutures and the flexing of the head has changed their aspect (Penthimiinae). In others, although the epicranial suture remains ventral, they have migrated to a marginal, and finally a dorsal, position by way of the anterior apex of the head (Ulopidae, Stenocotidae), whilst in others, in which the head has become greatly produced and flattened and no traces remain of the epicranial sutures, the ocelli have moved from their position at the apices of the frontal sutures to the edge of the head close in front of the eyes, and from thence on to the crown (Ledridae).

The shifting of the ocelli in the last two instances cannot have been brought about by changes in muscle stresses, but must be a direct response to light stimuli. Kennedy (1928) has pointed out that the majority of primitive living insects occupy environments of low intensity of light and heat, and that Mesozoic climates may have had a general lower level of intensity, so that changes in the position of the ocelli from a ventral to a dorsal aspect may have been a reaction to a change of environmental conditions.

Such changes from a hypothetical primitive head as have been described have taken place independently in several distinct groups. To illustrate this, attention is drawn to the illustrations on Plates VII, VIII, and IX; only numbers will be referred to, names for the time being ignored. On Plate VII, fig. 7, is shown the head most nearly approaching the supposed archetype, since a trace of an epistomal suture remains. In the nymph of this particular species, the suture is complete. Figs. 5 and 6, on Plate VIII, display the same feature, whilst Figs. 6, 8, 9, 10, and 11 (Plate VII) represent the next step, in which, although the epistomal suture is obliterated, the ocelli and the greater part of the vertex remain ventral in position. Figs. 1 and 3 on Plate VIII are of special interest, in that, although the epistomal suture is lost, traces remain of the subgenal suture.

How the ocelli may become dorsal, though remaining close to the epicranial suture, is shown on Plate VII, figs. 2 and 4, which illustrate species in related genera. Plate IX, fig. 13, is another instance. Steps in the movement of the ocelli from the underside to the top of the head, occurring both laterally and apically, are shown on Plate VIII, fig. 5, Plate IX, figs. 3, 4, 5, 11, and 12. Not only may all trace of the epistomal, coronal, and epicranial sutures be obliterated, but the frontal sutures may also disappear (Plate VIII, figs. 3, 4, and 7). Further discussion of the lines of development of leafhopper heads will be given in later sections. In order to make full use of head-shape and structure as a basis for phylogeny, a long series of forms must be studied before arriving at an estimate of the stability or otherwise of the various characters.

THE PROTHORAX.

A study of the prothorax is helpful, as it supplies valuable supporting evidence for use with other characters. On Plate IX the prothoraces of a number of species are figured in lateral aspect, and the principal point to be noted, and to which attention will be drawn later, is the width of the segment at the point of junction of the pronotum and propleurae. The episternum is seldom visible, being reduced and hidden by the head, but the epimeron (shaded in all figures) is seen to be wide dorsally in most of the figures, and narrow in only a few, and in only one case (fig. 10) is its dorsal ending hidden. The pronotum likewise may be wide laterally or very narrow.

HIND TIBIA.

Whilst the venation of the wings and tegmina are of greatest value in determining the limits of the principal jassoid groups, and the head supplies the most reliable characters for the separation of lesser groups, the hind tibiae are of subsidiary value. In the possession of elongated hind tibiae, armed with three or four rows of spines, the Jassoidea differ markedly from the Cercopidae, which have short, apically thickened hind tibiae armed with one or two stout spurs, and differ, though to a less marked extent, from the Membracidae, which have short hind tibiae, semi-circular in outline, that are covered with hairs, and may also have one or two rows of very small spines.

A number of types of tibial armature are illustrated on Plate X. The various figures will be referred to in connexion with the different families. It is supposed that the ancestors of present-day jassoids had hind tibiae that bore a row of long hair-like spines on one edge, two rows of evenly spaced spines arising direct from the tibia itself, and a row of spines mounted on prominent bases, that may have either decreased in size from the apex to the base, or have been of equal size. Such types are shown in figs. 1, 3, 4, 9, and 12. Changes have occurred in the elongation of the tibia, accompanied by a wider separation of the spines (figs. 8 and 11), the reduction in size and even disappearance of most of the spines and the increased development of one or a few spurs (figs. 5, 14, and 15), and in the reduction in size of the spurs and the addition of minute spines set between their bases (figs. 7 and 13). Of the four figures so far not mentioned, figs. 2 and 16 represent slight deviations from the supposed primitive type, whilst fig. 10 is the hind tibia of *Aethalion reticulatum,* which has more membracid than jassoid affinities, and fig. 6 represents the hind tibia of *Lasioscopus acmaeops* (Jac.), which, being a myrmecophile, has certain adaptive characters.

MALE GENITALIA.

For a long time the male genitalia have been a favourite character for use in specific determinations, and there is no doubt that their structure is of value for this purpose. The mere fact that they are usually the first part of an insect's body to show any morphological changes following species differentiation, would suggest that they are peculiarly unstable, and therefore likely to be of little use for the determination of the relationships of major groups. With certain reservations, this is held to be the case, yet Singh-Pruthi (1925), in his valuable work on the male genitalia of Hemiptera finds sufficient characters in these organs alone to suggest certain basic jassoid relationships.

The male genitalia of the Jassoidea are situated on the ninth, tenth, and eleventh abdominal segments. The ninth segment is very wide in the tergal region and narrow in the sternal region, and bears a pair of appendages, the sub-genital plates, or, as Snodgrass (1935) terms them, the harpagones. The aedeagus projects from the segmental membrane, which is a backward continuation of the body wall that separates the ninth from the tenth sternite, and may have a large basal apodeme for muscle attachment. It is usually attached to a phallobase, the basal plates of Singh-Pruthi, to which are connected accessory clasping organs, the parameres. With many genera the ninth segment extends posteriorly past the segmental membrane as a pair of protective flaps, the pygophores. In addition to the processes mentioned above, a pair of styles may be developed, either on the sub-genital plates or on the pygophores. The tenth segment is much reduced, and beyond it again is a still smaller sclerite, and the anal style. Following Singh-Pruthi, the sclerite between the tenth segment and the anal style is regarded as the greatly reduced eleventh segment.

On Plate XI are figured the male genitalia of twelve species of leaf-hoppers. Figs. 1 and 2, which represent the genitalia of *Bakeriola procurrens* (Jac.) and *Eurymela fenestrata* Le P. and S. respectively, differ from all the others in lacking any development of a pygophore, but the most noteworthy difference is that the phallobase or basal plates of these species, both of which belong to the Eurymelidae, have no connexion with the aedeagus. Wide apodemal processes serve instead for the attachment of the muscles that control the aedeagus, which is directed ventrally; this is universal throughout the family. Whilst the sub-genital plates of *E. fenestrata* are wide, and bear strong styles that arise from their ventral margins, those of *B. procurrens* are narrow and do not carry styles. The lack of styles is a character common to all species in the subfamily Ipoinae, but they are universally present with the Pogonoscopinae and Eurymelinae, but in one genus in the last mentioned family (*Eurymelita* Ev.) they arise from the dorsal and not the ventral margin of the sub-genital plates.

The genitalia of *Idiocerus kirkaldyi* Ev. (Plate XI, fig. 6) are of interest, because the basal plates, which are fused into a Y-shaped structure, are produced as a thecal sheath that invest the aedeagus, except at the distal end, resulting in the wide separation of the aedeagus from the basal plates proper. This suggests an approach to a condition such as is found in the Eurymelidae. Each side of the base of the exposed portion of the aedeagus is covered by the ends of narrow pleural plates that belong to the tenth segment. A somewhat similar structure is seen in fig. 4 (*Macropsis tasmaniensis* Ev.), but with this species a style is developed, and a process attached to the basal support of the aedeagus.

With *Eurinoscopus viridis* Ev. (Plate XI, fig. 3), although, as with *I. kirkaldyi*, the aedeagus base is at some distance from the parameres, the intervening space, in this instance, is bridged by the basal plates themselves. Fig. 5 (*Austroagallia torrida* Ev.) differs from the other genitalia illustrated in that the ninth segment is wide ventrally, but this is of no significance as species in related genera, figured by Lawson (1920), have the usual narrow ventral development of this segment.

Singh-Pruthi considers that the genitalia of the various groups can be *roughly* reduced to three sub-types, typically found in the Bythoscopinae, Jassinae, and Tettigoniellinae, also that the Jassine type is the central from which the other two can be derived. The genitalia of five other sub-families recognized by this author are considered by him to show a medley of relationships, as, for instance, the Megophthalminae (Paropiidae) essentially resemble the Bythoscopinae, but have sub-genital and basal plates of the Jassine type, and the Ledrinae possess characters of both the Tettigoniellinae and Bythoscopinae!

It is apparent that, whereas the male genitalia are of great value for specific differentiation; for determining the limits of a genus; and the degree of relationship between allied genera, with certain exceptions, they are of little help in deciding the affinities of major groups, except as subsidiary characters taken in conjunction with others of more dependable nature. As an example of the unreliability of deductions based on genitalia alone, attention is drawn to

Plate XI, figs. 1, 3, and 4, which represent the genitalia of three species of leaf-hoppers, all of which were formerly placed in the Bythoscopidae, and which might be supposed to be related on grounds other than the position of the ocelli, since all have long, narrow subgenital plates. The genitalia of *B. procurrens* (fig. 1) have already been shown to differ radically from all those figured, with the exception of *E. fenestrata* (fig. 2), even though superficial examination would not suggest affinity between these two species. Fig. 6 (*I. kirkaldyi*), also formerly placed in the Bythoscopidae, has only superficial resemblance to fig. 3, whilst fig. 5 (*Austroagallia torrida*), though previously classed in the Bythoscopidae, has no resemblance at all to either fig. 3 or 4.

PROPOSED CLASSIFICATION.

In a previous paper (Evans, 1936) the statement was made that it was unfortunate that the Palaearctic jassoid fauna was the first to be studied thoroughly, since the classification of other faunas has of necessity been based on this, and that it was believed that, when the Australian fauna was better known, new light would be shed on the whole jassoid complex.

In the system now presented the Jassoidea are divided into twenty-one families, a number of which are of doubtful status. In establishing this system of classification, due regard has been paid not only to morphological details, but also to general appearance, sculpturing, and coloration. In no case has a single characteristic, such as the position of the occelli, been allowed to assume undue importance.

After considerable thought it was decided to give each of the major divisions the rank of Family, as by so doing the arrangement of the lesser groups is facilitated. It is certain that the Aethalionidae and Eurymelidae are worthy of separation almost as complete as that of the Membracidae, but for convenience they are classed as ordinary jassoid families. Certain of the more recent families, such as the Euscelidae and Eupterygidae, which are represented by numerous genera and species, are not as distinct as others, such as the Paropiidae and Austroagalloididae, which are only represented by a few survivors from an earlier geological age. Families, such as the Euacanthidae are retained only provisionally because the author is familiar with but a few representatives, and hence is not in a position to determine their true status. The accounts of the various families are not intended as definitions, as such would be impossible without a full knowledge of the fauna of the world, and only brief mention is made of well-known established families for which no changes are proposed.

Aethalionidae

(Plate IV, fig. 4; Plate V, fig. 4; Plate VII, fig. 9; Plate X, fig. 10)

This family is confined to South America. Only one species, *Aethalion reticulatum* L., is known to me. Baker (1915) suggested that relationships might exist between this family and the Eurymelidae, but there is no resemblance between the two groups in a single character of any significance.

They have already been shown to differ from the rest of the Jassoidea in the venation of both the wing and the tegmen, and in the armature and shape of the hind tibia. The adult head displays several primitive characteristics, such as the ventral position of the ocelli and the persistence of the coronal and epicranial sutures. In the nymphs there is no suture separating the ante-clypeus from the fronto-clypeus, but an ill-defined epistomal suture occurs, traces of which may be seen in the adult head. Other features that serve to separate the Aethalionidae from the rest of the Jassoidea are the proximal fusion of the sub-genital plates and the large pronotum. Mr. China has informed me that species in this family are ant-attended, thus resembling the Membracidae in habits as well as in certain structural details.

Eurymelidae

(Plate IV, fig. 5; Plate V, figs. 3, 5, 7, 9; Plate VII, fig. 8; Plate X, figs. 4, 5; Plate XI, figs. 1, 2)

The Eurymelidae, which are the dominant family of leaf-hoppers in Australia, have two outstanding characters that separate them from the rest of the Jassoidea. The media of the tegmen has two, three, or four branches, and the aedeagus is completely separated from the basal plates. Apart from these features their appearance is distinct, and they can be recognized by their flattened face and more or less diamond-shaped fronto-clypeus, which is completely surrounded by well-defined sutures. The ocelli are always close to the junction of the frontal and epicranial sutures, well away from the posterior border of the head, and show no tendency to migrate to a marginal position. There are three distinct sub-families, the Ipoinae, Pogonoscopinae, and Eurymelinae. It is believed that the Ipoinae are the most primitive and that the Pogonoscopinae are a specialized off-shoot from the base of the Eurymeline stem.

The Ipoinae, of which thirteen genera, containing twenty-nine species, have so far been described (many more await description), feed principally on eucalyptus trees, but two species have been recorded from *Casuarina* sp., one from *Eremocitrus glauca*, and others occur on mistletoe *(Loranthus)* growing on various hosts. They range from small forms with narrow sub-genital plates to large species with wide sub-genital plates. Two species are of special interest; one of these, *Bakeriola procurrens*, which is confined to Western Australia, has hind tibiae with a complete armature of spines, whilst most eurymelids have a reduced armature, accompanied by spur development. The sub-genital plates are simple, being long and narrow without accessory styles; the tegmina are not tectiform, and the head facially is as wide as long. None of these characteristics are typical of the family, and suggest that *B. procurrens* is a generalized species, and may represent a type from which other forms have arisen. The other species of interest is *Cornutipoides tricornis* Ev., also from Western Australia (figured in Evans, 1934), which has a prominent horn on the head formed entirely of the frontoclypeus, and a pair of lateral horns arising from the vertex on each side. It differs from other described members of the family in having narrow maxillary plates and prominent globular eyes, and, as with the related *Cornutipo scalpellum* Ev., the media in the tegmen has three branches. It is assumed that, whilst the venational character is primitive, the others mentioned are due to extreme specialization.

The Eurymelinae, of which twenty-five species, contained in seven genera, have been described, range from forms very similar to the less specialized Ipoinae to large, brightly coloured species that have reduced tibial armature and large sub-genital plates.

The Pogonoscopinae, which are largely confined to Western Australia, and of which six species, contained in three genera, have been recorded, are all myrmecophilous and feed on the roots of eucalyptus trees.

Until raised to family rank by the present author in 1934, the Eurymelidae were included in the Bythoscopidae solely on account of the facial position of the ocelli. Singh-Pruthi suggested that, in the reduction of the basal plates and in the flap-like sub-genital plates, the group approached the Cercopidae, but a consideration of other characters lends no support to this view. Although now widespread in Australia and extending to New Guinea and New Caledonia, it is probable that this family developed in Western Australia in Cretaceous times, when that part of the present continent was separated from Eastern Australia by a wide sea (Tillyard, 1924). Their close association with trees of the genus *Eucalyptus* lends support to this view, since there is evidence to show that these trees date back to Cretaceous times (Seward, 1931). Though descended from an ancient stock, the wide variation in coloration and minor structural features that occurs in many genera, suggests that species differentiation is still in progress. Like the Membracidae and Aethalionidae, all the Eurymelidae are ant-attended, and in common with these groups the nymphs lack jumping powers, such as are common to all the rest of the Jassoidea.

Bythoscopidae

(Plate IV, fig. 6; Plate VI, fig. 6; Plate VII, figs. 1-4; Plate VIII, 7, 8; Plate X, fig. 1; Plate XI, fig. 3)

In an earlier paper (Evans, 1936), it was pointed out that the Bythoscopidae appear to comprise a heterogeneous collection of genera bound together by a single character of doubtful phylogenetic significance, the ventral position of the ocelli, and, in the paper referred to, the following Australian genera were placed in this family: *Eurinoscopus* Kirk., *Trocnada* Walk., *Chinaella* Ev., *Idiocerus* Lewis, *Pedioscopus* Kirk., *Austroagallia* Ev., *Austroagalloides* Ev., *Oncopsis* Burm., *Macropsis* Lewis, and *Stenoscopus* Ev..

With the exception of *Eurinoscopus*, *Trocnada*, and *Chinaella* it is now proposed to remove the above genera from the family and to add the following genera: *Penthimia* Germ., *Vulturnus* Kirk., *Neovulturnus* Ev., *Thaumatoscopus* Kirk, *Hecalus* Stal, *Reuteriella* Sign., and a genus not represented in Australia, *Gypona* Germ.. Only one point has received consideration in making these changes; whether or not the species in the various genera give evidence of phylogenetic affinities to *Bythoscopus* Germ.. It is realised that certain genera not represented in Australia should also be removed and others added, but those mentioned are sufficient for the present purpose. The reasons for discarding seven genera will be discussed in connexion with the families to which they have been relegated, but the first step is to explain why seven genera, none of which have previously been considered as having affinities to *Bythoscopus*, are placed in this family, and why three Australian genera have been retained in it.

Bythoscopus and Eurinoscopus

There has never been any doubt concerning the close relationships of these two genera, which differ solely in that the tegmen of *Eurinoscopus* is somewhat narrower than that of *Bythoscopus* and lacks the numerous costal cells present in the latter. Also species in the Australian genus are smaller and narrower than *B. lanio* L..

Eurinoscopus

As this genus, together with *Bythoscopus*, represents a basic type, the principal features are described. The head is much wider than long, has wide maxillary plates, a fronto-clypeus separated from the vertex by a perceptible though faint semi-circular suture, and prominent antennal ledges that extend from the eyes to the fronto-clypeus. The head (Plate IX, fig. 1) is neither evenly convex nor flat, and that part anterior to the antennal ledges lies at an angle to the rest. The tegmina overlap apically, and the area enclosed by the two branches of the first cubitus is not pigmented as is the rest of the tegmen, but forms a supplementary appendix. The wing (Plate IV, fig. 6) has the apices of R_{4+5} and M_{1+2} fused into a single vein, and the hind tibiae (Plate X, fig. 1) are flattened and slightly curved and bear an armature of regular spines, and when the insect is at rest the hind femora, which bear apical spines, lie against the wide propleurae.

Eurinoscopus and Chinaella

Chinaella (figured in Evans, 1936) differs from *Eurinoscopus* in the more declivous head and pronotum and the greater overlap of the tegmina apically.

Eurinoscopus and Trocnada

Trocnada resembles *Eurinoscopus* in all essential cephalic characters, but differs from it in that posterior to the antennal ledges the head is on a plane with the declivous pronotum and at right-angles to the anterior half of the head. Species in the two genera are similar in the venation of the tegmen, the possession of a supplementary appendix, the venation of the wing, the shape and armature of the hind tibiae, and in the structure of the male genitalia.

Eurinoscopus, Trocnada, and Penthimia

The close resemblance between the heads of insects in these three genera may be seen by a glance at Plates VII and IX. On Plate VII, figs. 1 and 2 and 3 and 4 represent the heads of *Penthimia americana* Fh. and *Trocnada gigantea* Ev. respectively, and on Plate IX, fig. 1, represents the head of *Eurinoscopus viridis* in profile, and fig. 2, *Penthimia americana* in the same aspect. The figures make discussion unnecessary, and all that need be mentioned is that in essential points of structure there is no difference between the three heads. Species in all three genera have the prothorax similar in shape, and the position of the hind femora and the shape and armature of the hind tibiae are identical. The tegmen of *Penthimia* approaches that of *Bythoscopus* more than *Eurinoscopus*, and the wing venation is of the normal jassoid type.

Eurinoscopus, Penthimia, Neovulturnus, Vulturnus and Thaumatoscopus

All the above genera, except the first, have been previously placed in the Penthimiidae (Evans, 1937, c), and their inter-relationships discussed. In the paper referred to, figures were given to show progressive change in head-shape from a species resembling *Eurinoscopus* (*Neovulturnus lapsus* Ev.) to one resembling *Penthimia* (*Neovulturnus maculosus* Ev.), and from such a type to a species with a produced foliaceous head (*Thaumatoscopus dunkensis* Ev.).

Neovulturnus, *Vulturnus*, and *Thaumatoscopus* resemble *Eurinoscopus* in having overlapping tegmina with supplementary appendices, wide propleurae, and hind femora that rest against the propleurae, and hind tibiae similar in shape and armature.

Eurinoscopus and Reuteriella

The head of *R. flavescens* (Plate VIII, fig. 7; Plate IX, fix. 3) differs from those of species in the genus *Eurinoscopus* in being considerably produced and flattened, and in lacking frontal and epicranial sutures, but resembles it in the shape of the maxillary plates and in having distinct antennal ledges that extend as far as the eyes. The pronotum is wide laterally and on a plane with the crown of the head, and the propleurae widely separate the eyes from the base of the tegmina. The latter are long and narrow, and have a supplementary appendix, and the wings have R_{4+5} fused apically with M_{1+2}. *Reuteriella* also resembles *Eurinoscopus* in characters supplied by the hind legs.

Reuteriella and Gypona

Gypona (Plate VIII, fig. 8 and Plate IX, fig. 5) differs from *Reuteriella* in having the ocelli on the crown of the head and not marginal, and in having a less produced head. However, in *Reuteriella*, the ocelli, though usually marginal, may be on the crown close to the margin, but not touching it. In both genera the coronal suture is distinct on the crown, but in neither does it extend to the apex, suggesting that the crown consists in part of the fronto-clypeus. so that the division of the head into dorsal and ventral surfaces may have started as in *Trocnada* and *Penthimia* and have been followed by a flattening process, as in *Thaumatoscopus*. The prothorax of *Reuteriella* is similar in shape to that of *Gypona*; the tegmina of both are long and narrow, but those of *Gypona*, although they overlap apically, lack a supplementary appendix, and in the wing of *Gypona*, although R_{4+5} is distinct from M_{1+2}, there is no cross-vein between them, and the veins touch at the point usually occupied by a cross-vein. The hind legs of *Gypona* are similar in shape and armature to those of *Reuteriella*, but the hind tibiae may have a few minute spines set between each of the largest spines.

Hecalus

Hecalus (Plate IX, fig. 4) must also be placed in the Bythoscopidae, although the head differs from those already described in lacking prominent antennal ridges, and in having a swollen fronto-clypeus.

The ocelli are on the margin of the head just in front of the eyes close to the apices of the frontal sutures. Epicranial sutures are absent, but the coronal suture is distinct and from its shortness it is evident that the greater part of the crown is of fronto-clypeal origin. The tegmina are short, do not overlap, and may be brachypterous in one sex. The wings have normal venation. Thus, although in certain characters this genus displays no obvious relationship with *Eurinoscopus* and other genera in the *Bythoscopidae*, it resembles them in the basic structure of the head, in the shape of the prothorax, and in the shape and armature of the hind tibiae.

It is not suggested that the genera placed in this family are all very closely related to one another, but it is maintained that they all have greater affinity to *Bythoscopus* than have such genera as *Agallia* and *Macropsis*, and than they themselves have to other genera, such as *Euscelis* and *Thamnotettix*. The family may be divided into three sub-families, the Bythoscopinae, Penthimiinae, and Gyponinae, the Penthimiinae being subdivided into the Penthiminii and Thaumatoscopini, and the Gyponinae into the Gyponini and Hecalini.

Euscelidae

(Plate VIII, fig. 10)

The Jassinae have presented in the past a bewildering collection of genera of doubtful affinities, linked together by the fact that all have the ocelli on the margin of the head. As understood here, this family includes only such genera as *Thamnotettix* Zett., *Chlorotettix* Van D., and *Selenocephalus* Germ, which are all related to *Euscelis* Brullé.

The Euscelidae are poorly represented in Australia, and no attempt is made to remove all the genera which have been placed in the Jassinae in the past, and which do not belong to the Euscelidae, although a number are changed to other families, and for certain groups of genera, new families are erected.

There is little doubt that the Euscelidae are not far removed from the Bythoscopidae, but are of more recent development. With the head, the frontal sutures diverge outwards, the eyes and the ocelli lie at their apices on the margin of the head or just above or below it. A distinct epicranial suture is never developed, but the coronal suture is almost invariably present, and the crown of the head consists in part of the fronto-clypeus and in part of the vertex. The propleurae may be wide or narrow, and usually separate the eyes from the bases of the tegmina, and the hind tibiae are heavily armed, but lack prominent spurs. No Acucephalini have been recorded from Australia. Lawson (1920), in defining this tribe, states that the ocelli are on the margin of the vertex or just above it, but much farther from the eyes than with the Jassini. Of the two species of this tribe available to me for study, *Acucephalus nervosus* (Schrank) and *Acucephalus fasciatus* L., the former is noteworthy in that the fronto-clypeus is confined entirely to the ventral surface of the head, and the flattened produced crown consists only of the vertex. Both species lack a marginal vein in the wing between R_{1+2} and Cu_1.

In so far as is known none of the Euscelidae are arboreal, but feed on low-growing plants, principally grasses.

Agalliidae.

(Plate VII, fig. 11; Plate XI, fig. 5)

This family, which comprises *Agallia* Curt., *Aceratagallia* Kirk., *Austroagallia* Ev., and related genera, contains a number of small insignificant species with certain distinctive cephalic characters, which serve to separate them from the rest of the Jassoidea.

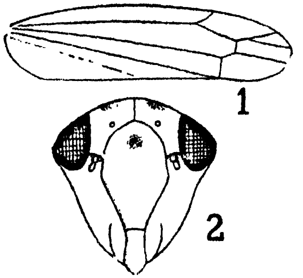
The clypeal suture forms a continuous line with the antennal ledges on each side of the head, and the epicranial sutures, which are usually perceptible, though never well-marked, proceed from above the antennal ledges and are joined by the coronal suture. There is no trace of frontal sutures, and hence the ocelli, which in most leaf-hoppers lie at the apices of the frontal sutures, are isolated. In the Idioceridae, which somewhat resemble the Agalliidae in superficial characters, frontal sutures are distinct, and epicranial sutures, when perceptible, occur as a transverse suture that joins the apices of the frontal sutures. The pronotum narrows laterally, the bases of the tegmina lying close behind the eyes; both tegmina and wings have normal complete venation, and the hind tibiae, which have numerous spines, lack prominent spurs.

All known species feed on grasses and other low-growing plants, none being arboreal.

Eupterygidae

(Plate VIII, fig. 12)

The Eupterygidae are usually considered as a distinct family or as a tribe of the Jassinae. The majority of species have a head such as shown on Plate VIII, fig. 12 *(Typhlocyba ulmi)*, which resembles *Euscelis*, in that the frontal sutures diverge towards the eyes, and there is no trace of an epicranial suture, but others have the frontal, epicranial, and coronal sutures distinct, which suggests that this family may have arisen from the same main stem as the Bythoscopidae independently of the Euscelidae. No named specimens with this character being available, recourse has been made to describing a new species of the genus *Empoasca* Walsh.



1. Tegmen of *Empoasca bancrofti.*
2. Head of *Empoasca bancrofti.*

Empoasca bancrofti, n. sp.

Length, 4 mm. *Head,* bright yellow with three large round black spots; eyes, black. *Pronotum,* yellowish-grey, medially black. *Scutellum,* yellow, lateral angles black. *Tegmen,* greyish-yellow. The rest of the body yellow. *Male Genitalia,* with the sub-genital plates broad basally and narrow apically and with short twisted parameres.

Type ♂, from Eidsvold, Queensland (coll. T. Bancroft), in the collection of the C.S.I.R. Division of Entomology at Canberra.

Idioceridae

(Plate V, fig. 10; Plate VII, fig. 12; Plate IX, fig. 8; Plate X, fig. 2; Plate XI, fig. 6)

This family is erected to contain leaf-hoppers in the genus *Idiocerus* Lewis and *Pediosccopus* Kirk., and in such other genera as are related to *Idiocerus,* but lack Australian representatives.

No attempt is made to define the limits of this family, but it will be shown that not only do species in the above genera give no evidence of close affinity with *Bythoscopus,* but also are they distinct from all other jassoid families. It is possible that Australian species that have been placed in the genus *Idiocerus* are not congeneric with the genotype, *I. adustus* H., but they are closely allied to it.

The head is flat or convex, but always in one plane, the crown, which consists solely of the vertex, never being sharply separated from the face. The antennal ledges are not prominent, and the antennae of the males may have disc-like swellings near the tip. The frontal sutures are distinct and the ocelli lie at their apices, and coronal and epicranial sutures, which are seldom clearly defined, lie as shown on Plate VII, fig. 12. The propleurae are narrow, and the bases of the tegmina lie close behind the eyes. The tegmina, which are long and narrow and usually hyaline, have wide appendices, and the venation may be reduced. Those species representative of the Palaearctic fauna figured by Melichar (1890), have R^{2+3} and R_{4+5} present as distinct veins, but all described Australian species have these veins partially fused (Plate V, fig. 10), whilst, with *Pedioscopus*, although the radius is reduced, the media is distinct from it basally.

The venation of the wing is of the usual type, and the slender hind tibiae have a few prominent spurs that decrease in size from the apex to the base. The male genitalia, which are of an unusual type, have already been discussed. So far as is known all species in this family are arboreal.

Austroagalloididae

(Plate VI, fig. 4; Plate VII, fig. 5; Plate IX, fig. 10)

In 1936 (Evans, 1936) a new genus *Austroagalloides* Ev. was defined to contain a number of leaf-hoppers that had ventral ocelli, superficially resembled species in the genus *Idiocerus*, and which were thought to be related to *Agallia*. Further analysis of their structure has led to the decision that insects in this genus are sufficiently distinct to merit separation as a family, and it is probable that the present genus, which contains seven described species, should be divided into two or three genera.

The head (Plate VII, fig. 5) in most species lies in three distinct planes, and consists of a wide crown which is entirely made up of the vertex, and which is separated from the rest of the head by a transverse ridge, followed at right-angles by a more or less rectangular area bounded by the eyes laterally and the antennal ledges anteriorly. The only sutures present in this area are the frontal sutures that terminate close to the ocelli. The anterior portion of the head is more or less parallel to the crown. The figure of the head should be compared with those immediately above it on Plate VII, both of the upper figures being representatives of the Bythoscopidae, and the following differences noted. The eyes of *Austroagalloides nigra* Ev. are considerably larger and no sutures are developed above the apices of the frontal sutures, and, whilst the ocelli of both *Penthimia americana* and *Trocnada gigantea* lie on the crown of the head close to the junction of the epicranial and frontal sutures, the crown of *A. nigra*, which is not shown in the figure, consists, as has already been mentioned, of the vertex only.

The pronotum (Plate IX, fig. 10) narrows laterally, and the bases of the tegmina lie close behind the eyes. The tegmina are long, narrow, and steeply tectiform, and have a very narrow appendix or none at all, and with the wings R_{2+3} is incorporated in the costal margin and not distinct. The hind tibiae have an armature of weak spines, either evenly spaced or reduced in numbers, and of the types figured resemble most closely Plate X, fig. 16. When the insect is at rest the proximal ends do not lie as far forward as the propleurae.

The family is confined to Australia, and all species feed on eucalyptus trees. Its representatives are especially abundant at altitudes over 3000 feet, although they also occur in areas subject to high temperatures and low rainfall.

Thymbridae

(Plate IV, fig. 7; Plate VII, fig. 10; Plate IX, fig. 7; Plate X, figs. 8 and 12)

The following genera, all of which are confined to Australia, New Guinea, and the neighbouring islands, are placed in this family, which was formerly considered (Evans, 1937, b) as a tribe of the Euscelidae: *Thymbris* Kirk., *Alseis* Kirk., *Epipsychidion* Kirk., *Putoniessa* Kirk., *Macroceps* Sign., *Rhotidoides* Ev., *Hackeriana* Ev., *Rhotidus* Stål.

In the more primitive genera, e.g., *Macroceps* (Plate VII, fig. 10), the head is much wider than it is long and the fronto-clypeus is small and entirely ventral. Posterior to the epicranial suture, but anterior to the ocelli, is a transverse ridge that extends right across the head to the eyes on each side. In genera, such as *Putoniessa* and *Rhotidoides*, with the backward extension of the fronto-clypeus, the ridge lies along the ventral apical border of the head, and the ocelli have moved from a ventral to a marginal position. In *Thymbris* the ridge is still perceptible, but the ocelli are on the crown, whilst in *Rhotidus* and *Hackeriana*, in which the head is produced and the ocelli on the crown, in the case of the former, well away from the apex; no trace remains of a transverse ridge or of the epicranial suture. Both the tegmina and the wings have normal venation; the pronotum is narrow laterally, and the hind tibiae are armed with prominent spurs that decrease in size from the apex to the base.

All known species are arboreal, and the majority are confined to eucalyptus trees.

Macropsidae

(Plate VI, fig. 7; Plate VII, fig. 6; Plate IX, fig. 6; Plate X, fig. 3; Plate XI, fig. 4)

It is difficult to understand why this well-distributed group of leaf-hoppers has been associated so long with *Bythoscopus*, since, apart from ventral ocelli, and the shape of the parameres and sub-genital plates, both characters of little phylogenetic significance, there are no features common to the two groups. Of the three genera present in Australia, two, *Macropsis* Lewis and *Oncopsis* Burm., are of world-wide distribution, whilst *Stenoscopus* Ev. is confined to Western Australia.

The head, as far as Australian species are concerned, lies almost entirely in one plane, and a crown, if present, is very narrow. The ante-clypeus and lorae are frequently somewhat swollen, the maxillary plates narrow, the clypeal sutures directed outwards towards the eyes, and the antennal scrobes form a continuous line with them.

Frontal, epicranial, and coronal sutures may be faintly indicated, as shown on Plate VII, fig. 6 (*Oncopsis pullus* Ev.), or not apparent, and a pair of compact sausage-shaped markings indicate the attachments of the muscles of the sucking-pump. The fronto-clypeus is usually small, the vertex is large, and the whole head is generally punctate or rugose. The pronotum, which may be declivous or raised into a hump, narrows laterally (Plate IX, fig. 6), and the bases of the tegmina lie close behind the eyes. The tegmina have normal venation, and frequently several angular cells are developed; they are tectiform, have narrow appendices, and do not overlap apically. The wing venation is distinct, as R_{2+3} and R_{4+5} are fused for their entire length. The hind tibiae are not flattened nor curved, and have a row of evenly-spaced short, strong spines (Plate X, fig. 3).

Of the three genera, fifteen species of *Macropsis*, seven species of *Oncopsis*, and one species belonging to the genus *Stenoscopus*, have been described from Australia. These represent but a fraction of the large numbers that await description, and it is probable that an intensive study of the family would lead to the erection of several new genera. As far as is known, all members of this family inhabit trees and shrubs.

Tartessidae

(Plate IV, fig. 8; Plate VI, fig. 8; Plate VII, fig. 7; Plate X, fig. 7; Plate XI, fig. 11)

This family is erected to hold a very distinct group of genera, three of which occur in Australia (*Tartessus* Stål, *Tartessella* Ev., and *Tartessoides* Ev.). Previously these genera had been included in the Euscelidae (Evans, 1937, b).

The head is of particular interest, because in the nymphs of some species of *Tartessus,* the frons is a distinct sclerite, and even in the adult head traces may remain of the epistomal suture (Plate VII, fig. 7). The ocelli lie at the corner of the frons, close to the junction of the frontal and epicranial sutures, and may be either ventral, marginal, or dorsal, and the crown may consist entirely of the vertex or of the vertex and a narrow frontal margin. The tegmina have several cells, and a wide appendix that extends to the costal margin, and in *Sarpestus specularis* Spangb., a New Guinea species, traces remain of the sub-costal vein. In this genus the media is fused for the greater part of its length with the radius. The wing is unique amongst the Jassoidea, in having a marginal or ambient vein that continues on to the anal area. The hind tibae have three rows of long, strong spines and one row of fine hair-like spines, and between each of the spines of one row, all of which are set on swollen bases, occur a few minute spines. This development of minute interpolated spines is of little significance as it has occurred independently in several groups.

All species in this family are arboreal, and the Australian representatives, although not confined to eucalyptus trees, are principally associated with them.

Jassidae

(Plate VII, fig. 14)

This family is only known to me from two species belonging to the genus *Jassus* Fabr. The head of one of these, which is illustrated on Plate VII, fig. 14, is long and narrow, and the frontal sutures lie close to the eyes on each side. The ocelli are marginal, and the coronal suture joins the transverse epicranial suture at the apical margin of the head, thus the wide crown consists entirely of the vertex. The tegmina superficially resemble those of *Tartessus,* as the wide appendix continues as far as the costal border. The male genitalia are of interest, since the aedeagus is very long and the basal plates short.

Species in this family resemble the Tartessidae, as the epicranial suture lies along the ventral posterior margin of the head, and is transverse, but in the lengthening and narrowing of the face they differ widely from all other genera that have arisen from the Bythoscopoid stem. Only a single genus, *Tharra* Kirk., belonging to this family has been recorded from Australia.

Cicadellidae

(Plate VI, fig. 9; Plate VIII, fig. 9; Plate IX, fig. 13; Plate X, fig. 13)

This well-differentiated family needs little comment, its most outstanding characteristic being that not only does the hind-most portion of the fronto-clypeus form part of the crown, but the attachment impressions of the muscles of the sucking-pump extend on to the crown. The frontal sutures are also on the crown of the head and are always distinct, and traces may remain of a transverse epicranial and a longitudinal coronal suture. The ante-clypeus and the post-clypeus are usually swollen, the pronotum is wide laterally, and the tegmina long and narrow. The hind tibiae have an armature of strong spines, but lack spurs, and may have minute spines between each of the most prominent spines.

This family, members of which feed principally on grasses, is poorly represented in Australia, only one genus, *Cicadella* Latreille, having been recorded.

Euacanthidae

(Plate VII, fig. 16; Plate IX, fig. 14)

Euacanthus Le P. and S. does not occur in Australia, but three Australian species have been placed in a genus *Euacanthella* Ev., which is believed to be related to *Euacanthus*.

The family contains species that are similar in general appearance to members of the Cicadellidae, but which differ in that, although the hind portion of the fronto-clypeus extends on to the crown, the frontal sutures are ventral, the ocelli, though dorsal, are close to the margin of the head, and a transverse dorsal ridge marks the position of the epicranial suture. It is possible that the area between this ridge and the apex of the head represents the remains of the frons. The pronotum is wide laterally in *Euacanthus*, though narrow in *Euacanthella*, and in both genera the ante- and post-clypeus are swollen. The tegmina are short and rounded apically and lack a cross-vein (M_{1+2}) joining the media to the radius. The hind tibiae are armed with evenly-spaced spines of equal size mounted on slightly protuberant bases and with minute spines set between them. All species known to me are grass-feeders.

Pythamidae

(Plate VII, fig. 13)

This family is only known to me by one species, *Mainda praeculta* Dist., the head of which is figured, although two Australian genera, *Tortor* Kirk. and *Dryadomorpha* Kirk., have been described. For particulars of the characteristics of this family, reference should be made to Baker, 1923. This author has pointed out that the Pythamidae have affinities to the Euacanthidae and Signoretidae rather than to the Cicadellidae.

Signoretidae

(Plate VI, fig. 10; Plate VII, fig. 15; Plate IX, fig. 15; Plate X, fig. 16)

No representatives of this Oriental family occur in Australia. A number of illustrations are given of *Preta gratiosa* Mel., and it will be seen that, although in cephalic characters this species would appear to be close to *Euacanthus*, the tegminal venation and armature of the hind tibiae are of a distinctive nature.

Nirvaniidae

(Plate VIII, fig. 11)

Four species contained in four genera have been described from Australia, but these insects are rare, and for a discussion of this family reference should be made to the work of Baker, mentioned above. The head of *Nirvana pallida* Mel. is figured; with this species the frontal sutures are short, and it is probable that the produced crown consists solely of the vertex.

Stenocotidae

(Plate V, fig. 8; Plate VIII, figs. 5, 6; Plate X, figs. 9, 11; Plate XI, figs. 8, 9)

The Stenocotidae, with the exception of a single genus, are confined to Australia. The face of the head is usually flattened and as wide as long, and the fronto-clypeus in certain species is separated into a frons and post-clypeus, the arched epistomal suture persisting in a reduced form (Plate VIII, fig. 5). The ocelli, which lie at the apices of the frontal sutures, may be ventral or dorsal or lie in marginal depressions. The tegmina in all Australian representatives have the anal veins fused apically, and the hind tibiae have distinct spurs, decreasing in size from the apex to the base. Sexual dimorphism occurs in some genera.

Baker (1923), in a discussion of the position of the genus *Koebelia* Baker, which occurs in Western North America, suggested that it lay between *Stenocotis* Stål and *Ulopa* Fall., but was sufficiently distinct from either to merit the erection of a family, the Koebeliidae, to contain it. This genus is now transferred to the Stenocotidae, because of the close similarity of head structure between *Kyphoctis tessellata* Kirk. and *Koebelia californica* Baker (Plate VIII, figs. 5 and 6). The resemblance is not confined to these two species, as the frons of *Stenocotis* is also similar in shape to that of *Koebelia*. A Y-vein is not developed with *Koebelia*, and the hind tibiae (Plate X, fig. 9), though lacking spur development, is of a primitive type, from which that of *Stenocotis* might well have been derived. The male genitalia of *K. californica* and *Smicrotis* sp. are shown on Plate XI, figs. 8 and 9, and it will be noticed that both species have an aedeagus with a very long basal prolongation.

All the Australian Stenocotidae are arboreal and confined to eucalyptus trees. The habits of *K. californica* are unknown to me.

Ulopidae

(Plate VI, fig. 3; Plate VIII, fig. 1)

The Ulopidae are a family of small leaf-hoppers, members of which, according to Baker (1923), ' possess a character that is unique among jassoid insects, namely strongly rounded genae, the sharp outer edge of which curves mesad to the front above the lorae, leaving the latter with the outer border apparently free in facial view.'

On Plate VIII, fig. 1, is shown the head of the European *Ulopa reticulata* Fabr., with which the maxillary plates have been moved slightly out of position, and it will be seen that the distinctive characteristic of this family is nothing more than the persistence of the sub-genal suture, which, as shown in fig. 3 on the same plate (*Anacephaleus ulopae* Ev.), may also occur with the Ledridae, although exceptional in this family.

The Ulopidae are too well known to need further discussion, but it may be mentioned that the wide crown consists entirely of the vertex, and that ocelli, if present, lie well away from the frontal and epicranial sutures, having migrated to the crown independently of the backward development of the fronto-clypeus. One genus, *Austrolopa* Ev., has so far been described from Australia. It is believed that all species in this family feed on grasses.

Paropiidae

(Plate VIII, fig. 2)

The Paropiidae are another well-known family of small leaf-hoppers, and are related to the Ulopidae. As may be seen from the figure of the head of *Megophthalmus scanicus* Fall., the frontal and epicranial sutures are replaced by wide carinae, and the marginal depressions that contain the ocelli and the crown are formed from the vertex. A single genus, *Kahavalu* Kirk., has been recorded from Australia.

Ledridae

(Plate VI, fig. 5; Plate VIII, figs. 3, 4; Plate IX, figs. 11, 12; Plate X, figs. 14, 15; Plate XI, fig. 7)

The Ledridae comprise a heterogeneous collection of genera that might well be divided into three families, but which for the moment are grouped in three sub-families. The Ledrinae in which the Palaearctic genus *Ledra* F. occurs, contains six described Australian genera *Ledropsis* White, *Ledramorpha* Stål, *Jukuruka* Dist., *Porcor* Dist., *Rubria* Stål, and *Platyledra* Ev.

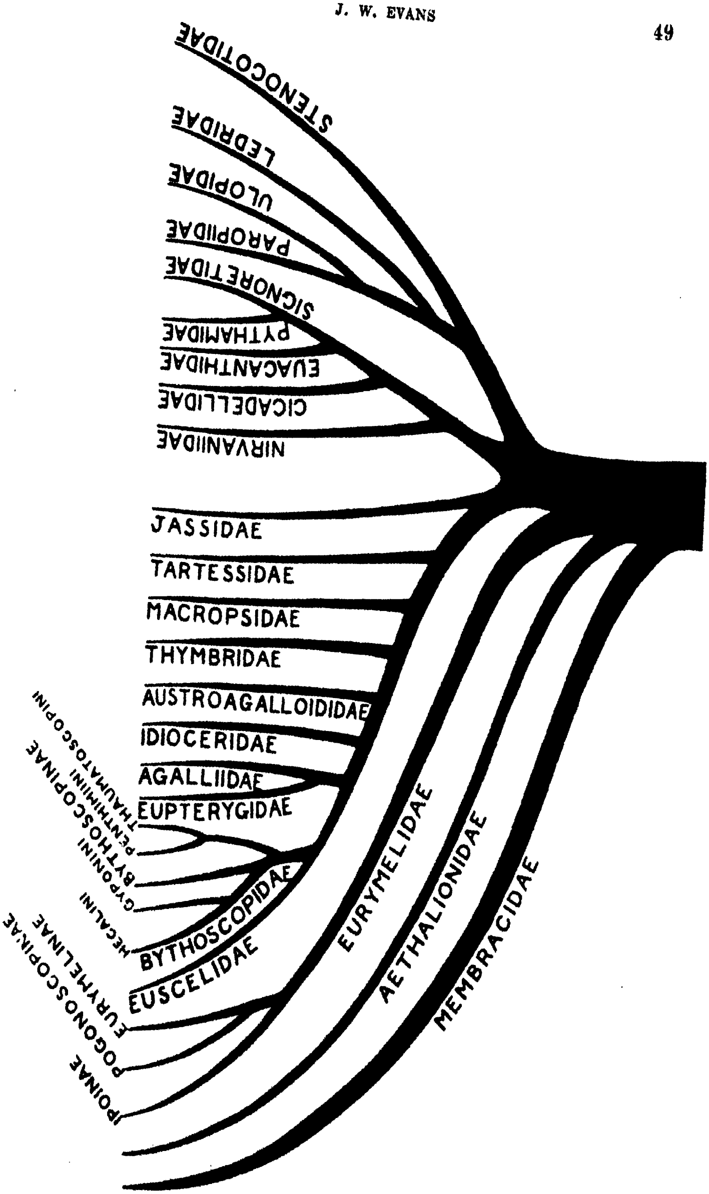
Insects in this sub-family have the head considerably flattened, widely produced, and concave ventrally. The ante-clypeus is narrow, often pear-shaped, and the post-clypeus includes nearly all that part of the head, both the face and the crown, that lies between the antennae and the ocelli. Although the coronal suture may appear to extend to the apex of the crown, a study of nymphal heads shows that it terminates close to the ocelli, and the obsolete frontal sutures, which are perceptible in *Ledropsis crocina* Dist., terminate at the ocelli. Thus the ocelli have migrated to their present dorsal position by way of the side of the head and not over the apical margin. The posterior median swollen ventral portion of the post-clypeus, although differentiated from the flattened lateral portions, is not separated from them by sutures; no well-marked antennal ledges are developed, and the eyes are prominent. The pronotum is collar-like, and may be raised into flap-like processes; the tegmina may have simple or recticulate venation, and the hind tibiae are considerably flattened and may lack spines or spurs, but usually one or a few spurs remain. In spite of the fact that species in the genus *Dorycephalus* Kirsch have marginal ocelli and hind tibiae with numerous spines, it is thought that they represent a primitive ledrid type, and are herewith transferred to the Ledrinae. The head and pronotum of *Dorycephalus platyrhynchus* Osb. is figured on Plate IX, fig. 12, and should be compared with that of *Rubria carnosa* Stål (fig. 11).

Two genera described recently (Evans, 1937, a), *Ledrella* Ev. and *Ledraprora* Ev., are placed in a new sub-family the Ledrellinae. Species in this group resemble those in the Ledrinae in the venation of the tegmina, in having prominent eyes and in the ocelli being on the crown, which in the case of *Ledraprora* is narrowly produced and consists almost entirely of part of the fronto-clypeus. The hind tibiae are flattened and similar in armature and shape to that figured on Plate X, fig. 3. They differ in the possession of distinct antennal ledges and a wide ante-clypeus; the head is not spatulate, and the pronotum, though wide laterally, is not collar-like.

The third sub-family, the Cephalelinae, has been defined previously (Evans, 1937, a). Insects in this group differ from those in the other two in their smaller size, in having deep antennal pits, in having the ventral posterior surface of the fronto-clypeus evenly concave or convex, not raised centrally, and in having hind tibiae which are not flattened, but short and feebly spinose. They resemble them in that the frontal and epricranial sutures are obsolete, the produced crown consists largely of the fronto-clypeus, the ocelli are on the disc of the crown, and the pronotum is collar-like.

PHYLOGENETIC TREE

A phylogenetic tree is reproduced on p. 49 to indicate the possible inter-relationships of the various jassoid families. With only the tibiamelidae and Bythoscopidae are lesser divisions shown, and with ter family only a few of the many that probably exist.


STENOCOTIDAE
LEDRIDAE
ULOPIDAE
PAROPIIDAE
SIGNORETIDAE
PYTHAMIDAE
EUACANTHIDAE
CICADELLIDAE
NIRVANIIDAE
JASSIDAE
TARTESSIDAE
MACROPSIDAE
THYMBRIDAE
AUSTROAGALLOIDIDAE
IDIOCERIDAE
AGALLIIDAE
EUPTERYGIDAE
THAUMATOSCOPINI
PENTHIMIINI
BYTHOSCOPINAE
GYPONINI
HECALINI
BYTHOSCOPIDAE
EUSCELIDAE
EURYMELINAE
POGONOSCOPINAE
IPOINAE
EURYMELIDAE
AETHALIONIDAE
MEMBRACIDAE

HABITS AND FOOD-PLANTS

Little is known about the habits of leaf-hoppers, but the Eurymelidae differ from all other jassoid families, with the possible exception of the Aethalionidae, in that they are ant-attended and the nymphs lack jumping powers. In only a few groups, such as the Eupterygidae, do both arboreal and grass-feeding species occur, and it is seldom that one species will feed indiscriminately on both types of plant, though it does happen, as recorded by DeLong (1923) in the case of *Gypona octolineata* (Say), which occurs on a variety of weeds, grasses, shrubs and trees. Very few specific food-plants of Australian leaf-hoppers have been recorded, but it is known that the majority feed on eucalyptus trees. Only one species (*Eurinoscopus elegans* Ev.) has been taken on *Acacia* spp., which, after the eucalypts, are the dominant Australian trees, and on which several species of membracids feed. None has been taken on any of the Proteaceae.

Whilst the Eurymelinae, Pogonoscopinae, and most of the Ipoinae, all the Thymbridae, Austroagalloididae, Stenocotidae, Australian Idioceridae, and most of the Tartessidae feed on eucalypts, none of the Macropsidae have been taken on these trees, but have been found on a variety of low-growing shrubs.

All the Australian Euacanthidae, Euscelidae, Ulopidae, Cicadellidae, Cephalelinae, and Agalliidae, so far as is known, feed on grasses, weeds, and plants of a similar habit. In general it is found that most leaf-hoppers with ventral ocelli are arboreal, whilst those with dorsal and marginal ocelli feed on grasses and other low-growing plants.

SIZE, COLORATION AND SCULPTURE

The size, coloration, and sculpture of leaf-hoppers are of assistance in determining relationships. It would seem that, with certain exceptions, the most primitive groups of present-day leaf-hoppers are small, and the general tendency has been towards an increase rather than a decrease in size. In the Eurymelidae, which includes the largest leaf-hoppers, the more generalized species, such as *Bakeriola procurrens*, are smaller than the more specialized, such as *Ipo pellucida* F. and *Eurymelops bicolor* (Burm.). Similar examples could be given for the Stenocotidae. All the Ulopidae are small, likewise the Cephalelinae and the large size of several Ledrids conforms with the idea that they may be highly specialized types descended from an extinct primitive stem. On the phylogenetic tree the Agalliidae and Eupterygidae are shown as arising from the same side-branch; this is because the factor of size as well as structure has been taken into account.

Leaf-hoppers are ornamented with a wide variety of colour patterns. In the Ledridae, Ulopidae, Paropiidae, and Stenocotidae, no bright colours are developed, various shades of brown being predominant. In the Ipoinae and Pogonoscopinae yellow, black, and brown markings only occur, whilst the Eurymelinae, though largely black, may have vivid orange, red, and yellow coloration, but green, the principal pigment in many families, is never present.

The body-sclerites of most leaf-hoppers are smooth, yet many have transverse striations on the pronotum and raised carinae may be developed on the head and prothorax. All the Macropsidae have the head and pronotum punctate or rugose, as to a lesser extent is the case in the Austroagalloididae. This characteristic alone serves to differentiate these families from the Bythoscopidae.

Generic and Specific Differentiation

Any attempt to arrange the components of a group of insects of such ancient lineage as the Jassoidea into a system based on natural relationships, must always be complicated by two factors. First, the picture is incomplete, like a jig-saw puzzle of which most of the pieces are missing. Secondly, confusion is liable to occur because of parallel evolutionary trends. Considered as a whole, the Jassoidea are a remarkably homogeneous group, doubtless because they occupy the same environment during both their immature and adult life, and the types of environment available are limited, hence but few adaptive characters have been developed. They may be tree or shrub-inhabiting insects or live in pastures and similar environments; a few are myrmecophiles. Most of the arboreal forms are confined to a single species or genus of plants, and a few (certain Eupterygidae) have alternate seasonal food-plants, and migrate from deciduous to evergreen trees.

Five types of evolutionary development can be recognized. In one type new species and later genera have resulted from isolation, either geographical or as the result of the adoption and retention of a new food-plant. Such changes as accompany isolation usually lack direction, and may in the case of new food-plants be due to a physico-chemical reaction resulting from the nature of the cell-sap ingested. Another group of evolutionary changes is caused by a gradual re-orientation of muscle fibres that causes a change of shape of certain body sclerites. Changes of an orthogenetic nature that confer no benefit on the organism, and do not appear to be in response to any stimulus, also occur, and finally those of an adaptive nature and those due to mutations.

It is not proposed to discuss the classification on an evolutionary basis of all the families, but only to give examples selected from a few, and to show how, in many instances, it is difficult to decide upon the limits not only of genera, but also of species.

In the Eurymelidae genera are plentiful and species few, and the genera, which are clear-cut, may be of mutational origin. Certain species in this family (e.g., *Eurymela fenestrata*) have numerous constant colour varieties, whilst in other species (e.g., *Eurymeloides punctata* Sign.) variable colour varieties occur. It is possible that some of these colour varieties may occupy different areas, or the same area, and may not inter-breed, and hence may represent incipient or true species. Possible incipient species also occur in such genera as *Rhotidoides*, where minor colour variation is often accompanied by slight structural differences largely affecting the extent of the crown. In the genus *Cicadella*, several Australian species occur with which changes in colour pattern are invariably accompanied by minor morphological changes. The above examples are concerned with specific differentiation; in other groups specific differences are well-established, but generic ones indefinite.

In the Bythoscopidae, *Neovulturnus lapsus* differs in head structure from *Thaumatoscopus dunkensis* to such an extent that the two species might well be placed in different families, yet a complete series of intergrades occurs between them. Similar series are found in the Cephalelinae between *Anacephaleus* Ev. and *Cephalelus* Perch, and in the Eupelicinae between *Dorydium* Burm. and *Paradorydium* Kirk. Such series of changes would appear to be along orthogenetic lines.

In the above instances species development has resulted from a progressive development in a definite direction, in each case concerned with the shape of the head. In many genera, such as *Oncopsis* and *Macropsis*, although species are distinct in colour pattern and morphological differences, no trends in any particular direction have been noted. In the Bythoscopidae it is believed that evolution has proceeded in several directions from a basic type resembling *Eurinoscopus*, whilst the present-day Ledrids, which give little evidence of evolutionary direction, are probably the remnants of an ancient group of which no primitive types survive.

ORIGINS OF AUSTRALIAN FAUNA

In this section the problem of leaf-hopper distribution is only discussed from the Australian point of view. Of the twenty-one families given in the new classification, representatives of all but two, the Aethalionidae, which are confined to South America, and the Signoretidae, which are an Oriental family, occur in Australia.

Tillyard (1924) has given a table showing the known sources of the present Australian and New Zealand faunas, in which are ten divisions extending from Upper Permian to Late Tertiary times. Only four divisions need be considered here, of which the representative faunal elements are the Middle Austro-Malayan of Upper Cretaceous and Early Tertiary times, the Last Antarctic of Middle Tertiary times, the Autochthonous xerophytic element of Tertiary times, and the Late Austro-Malayan of Late Tertiary times.

It is suggested that the Bythoscopidae and Tartessidae are part of the Middle Austro-Malayan element, that the Euscelidae, Eupterygidae, Agalliidae, Macropsidae, and Idioceridae form part of the last Antarctic element that reached Australia in Mid-Tertiary times, and that the Jassidae, Euacanthidae, Pythamidae, Cicadellidae, and Nirvaniidae, none of which are well represented in Australia, and all of which are largely though not entirely confined to north-east Australia, form part of the Late Austro-Malayan element.

The Thymbridae and Austroagalloididae form part of the indigenous xerophytic fauna as do also the Stenocotidae, but the last named family, together with the Ulopidae, Ledridae, and Paropiidae, all of which are to-day represented by the survivors of an ancient well-distributed fauna, may have originated in Cretaceous or even earlier times. The Eurymelidae possibly belong to the Western Australian element of Cretaceous times.

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Note.

After the completion of this paper a small collection of leafhoppers was received from Dr. A. Zachvatkin. Amongst them was a specimen of *Macroceps ahnegeri* Mel. This species is not congeneric with the genotype, *Macroceps fasciatus* Sign., but, together with *Achrus nigronervosus* Lind., *Symphypyga leopardina* Hpt., and *S. albigutta* V.K., and doubtless other species, would appear to represent a distinct group, differing from any considered in the foregoing pages. All these insects have a fronto-clypeus that is considerably swollen, small antennal scrobes, a vertical vertex, and hence no development of a crown, rounded frontal and epicranial sutures, and no coronal suture. The tegmina may have recticulate venation, and the hind tibiae have two rows of closely-set slender spines and one row of widely-spaced spines, mounted on distinct but not prominent bases.

Several species of *Melicharella* Sem. were included in the collection. In spite of superficial differences in a number of morphological features, it is certain that this genus, and also *Symphypyga obsoleta* Hpt., are related to *Austroagalloides* and belong to the same family.

Unfortunately specimens of *Adelungia*, sent by Dr. Zachvatkin, were damaged in transit.

In addition to the above, a specimen of *Eupelix cuspidata* F. has been received from Mr. China. This species does not belong to the Euscelidae, and a consideration of its structure, sculpture, and coloration has led to the decision to place it in a sub-family of the Ledridae, the Eupelicinae.

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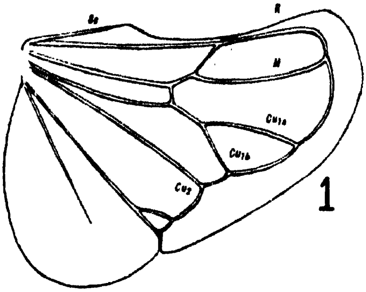
EXPLANATION OF PLATES.

PLATE IV

Fig. **1.—Wing of *Hindola compacta* (Cercopidae, Machaerotinae).**
Fig. **2.—Wing of *Cercopis jactator* (Cercopidae, Cercopinae).**
Fig. **3.—Wing of *Sextius virescens* (Membracidae).**
Fig. **4.—Wing of *Aethalion reticulatum* (Aethalionidae).**
Fig. **5.—Wing of *Eurymeloides punctata* (Eurymelidae).**
Fig. **6.—Wing of *Bythoscopus lanio* (Bythoscopidae).**
Fig. **7.—Wing of *Putoniessa rivularis* (Thymbridae).**
Fig. **8.—Wing of *Tartessus fulvus* (Tartessidae).**

PLATE IV



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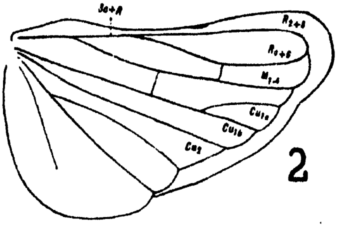

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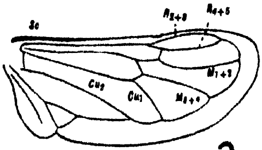

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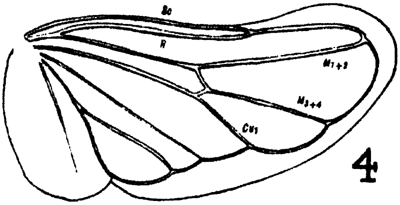

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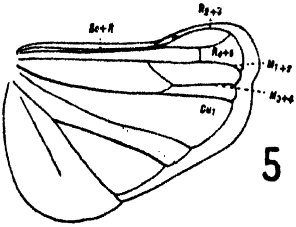

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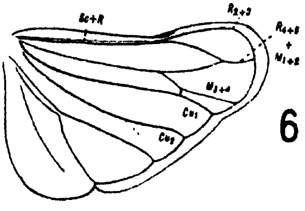

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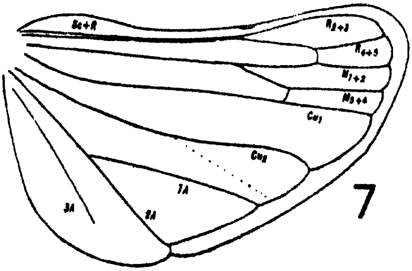

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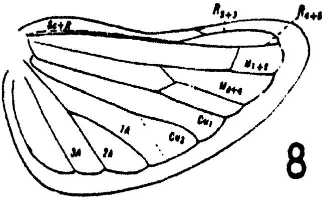

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PLATE V

Fig. 1.—Hypothetical tegmen of common ancestor of Permian Homoptera. (After Carpenter, 1933.)

Fig. 2.—Hypothetical tegmen of common ancestor of recent Jassoidea.

Fig. 3.—Tegminal pad of pre-imaginal instar of *Eurymelops rubrovitatta*.

Fig. 4.—Tegmen of *Aethalion reticulatum* (Aethalionidae).

Fig. 5.—Tegmen of *Eurymelita terminalis* (Eurymelidae).

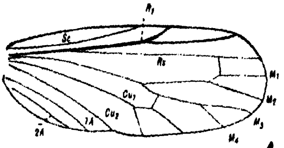
Fig. 6.—Tegmen of *Paradorydium menalus* (Euscelidae).

Fig. 7.—Tegmen of *Cornutipo scalpellum* (Eurymelidae).

Fig. 8.—Tegmen of *Kyphoctis tessellata* (Stenocotidae).

Fig. 9.—Tegmen of *Bakeriola procurrens* (Eurymelidae).

Fig. 10.—Tegmen of *Idiocerus seckeri* (Idioceridae).



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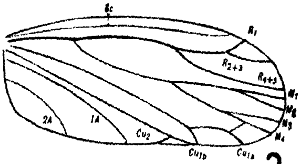

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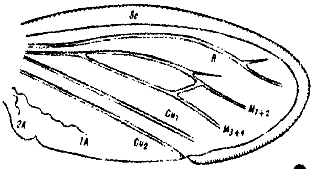

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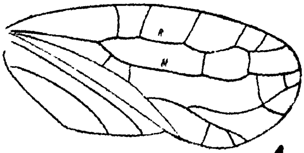

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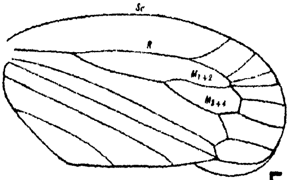

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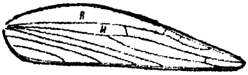

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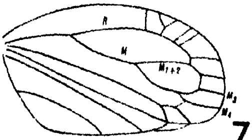

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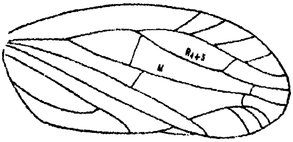

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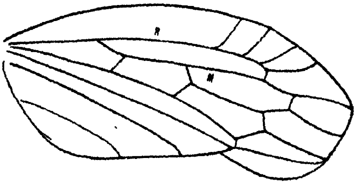

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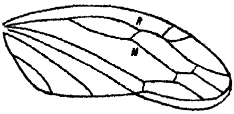

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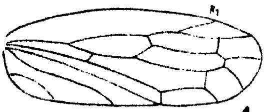
PLATE VI

Fig. 1.—Tegmen of *Rubria sanguinea* (Ledridae).
Fig. 2.—Tegmen of *Macroceps tonnoiri* (Thymbridae).
Fig. 3.—Tegmen of *Austrolopa kingensis* (Ulopidae).
Fig. 4.—Tegmen of *Austroagalloides karoondae* (Austroagalloididae).
Fig. 5.—Tegmen of *Anacephaleus carribensis* (Ledridae).
Fig. 6.—Tegmen of *Trocnada gigantea* (Bythoscopidae).
Fig. 7.—Tegmen of *Stenoscopus drummondi* (Macropsidae).
Fig. 8.—Tegmen of *Sarpestus specularis* (Tartessidae).
Fig. 9.—Tegmen of *Cicadella pasiphae* (Cicadellidae).
Fig. 10.—Tegmen of *Signoretia aureola* (Signoretidae).



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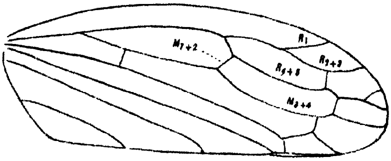

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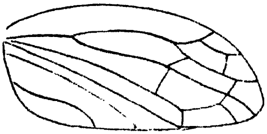

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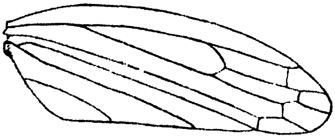

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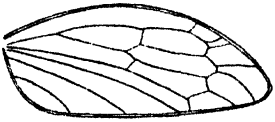

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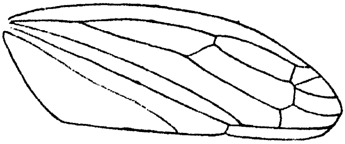

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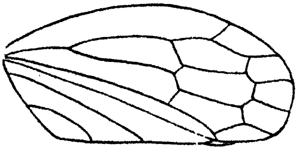

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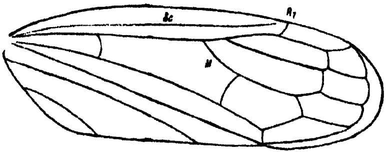

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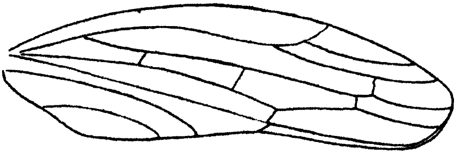

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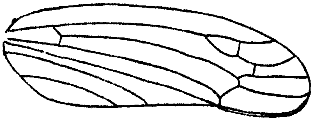

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PLATE VII

Figs. 1 and 2.—Head of *Penthimia americana* (Bythoscopidae).
Figs. 3 and 4.—Head of *Trocnada gigantea* (Bythoscopidae).
Fig. 5.—Head of *Austroagalloides nigra* (Austroagalloididae).
Fig. 6.—Head of *Oncopsis pullus* (Macropsidae).
Fig. 7.—Head of *Tartessus blundellensis* (Tartessidae).
Fig. 8.—Head of *Opio multistrigia* (Eurymelidae).
Fig. 9.—Head of *Aethalion reticulatum* (Aethalionidae).
Fig. 10.—Head of *Macroceps fasciatus* (Thymbridae).
Fig. 11.—Head of *Austroagallia torrida* (Agalliidae).
Fig. 12.—Head of *Idiocerus leurensis* (Idioceridae).
Fig. 13.—Head of *Mainda praeculta* (Pythamidae).
Fig. 14.—Head of *Jassus indicus* (Jassidae).
Fig. 15.—Head of *Preta gratiosa* (Signoretidae).
Fig. 16.—Head of *Euacanthus interruptus* (Euacanthidae).

cs., coronal suture; es., epicranial suture; fs., frontal suture; v., vertex; eps., epistomal suture; fc., fronto-clypeus; ac., ante-clypeus; cls., clypeal suture.

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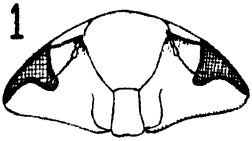

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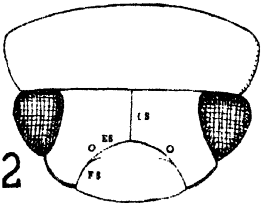

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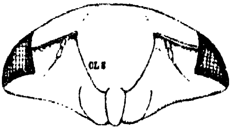

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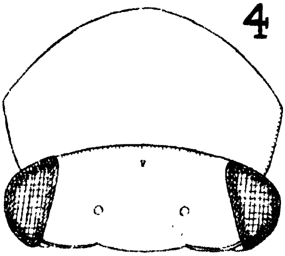

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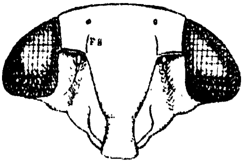

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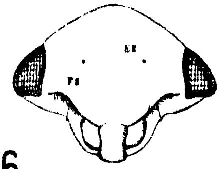

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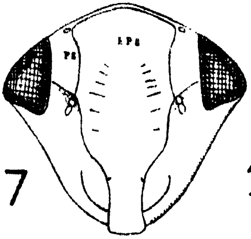

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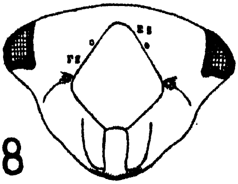

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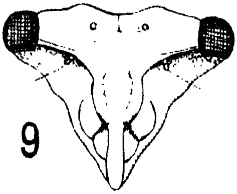

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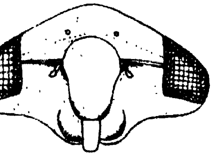

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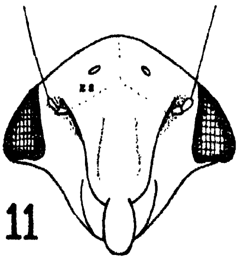

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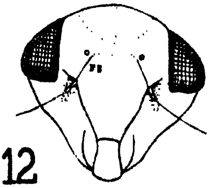

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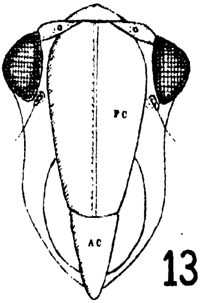

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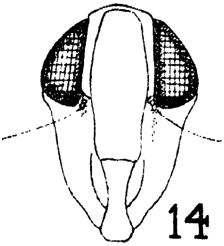

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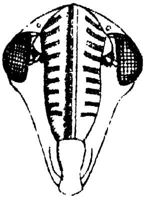

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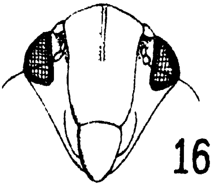
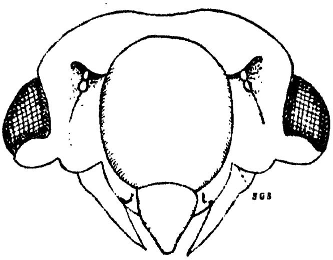


PLATE VIII

Fig. 1.—Head of *Ulopa reticulata* (Ulopidae).
Fig. 2.—Head of *Megophthalmus scanicus* (Paropiidae).
Fig. 3.—Head of *Anacephaleus ulopae* (Ledridae).
Fig. 4.—Head of *Ledropsis crocina* (Ledridae).
Fig. 5.—Head of *Kyphoctis tessellata* (Stenocotidae).
Fig. 6.—Head of *Koebelia californica* (Stenocotidae).
Fig. 7.—Head of *Reuteriella flavescens* (Bythoscopidae).
Fig. 8.—Head of *Gypona angulata* (Bythoscopidae).
Fig. 9.—Head of *Cicadella circulata* (Cicadellidae).
Fig. 10.—Head of *Deltocephalus obliquus* (Euscelidae).
Fig. 11.—Head of *Nirvana pallida* (Nirvaniidae).
Fig. 12.—Head of *Typhlocyba ulmi* (Eupterygidae).

sgs., sub-genal suture; f., frons; pc., post-clypeus; fs., frontal suture; es., epicranial suture.



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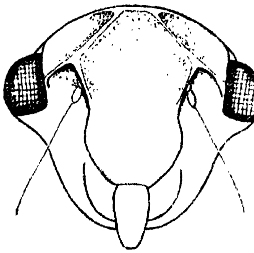

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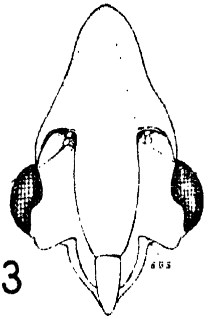

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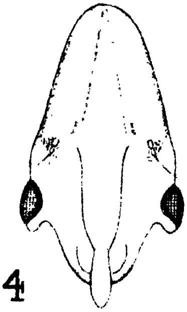

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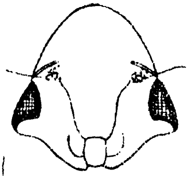

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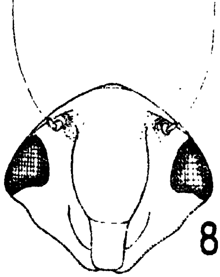

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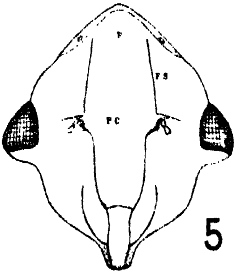

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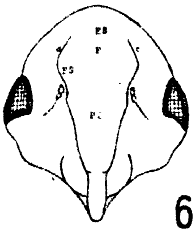

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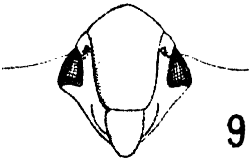

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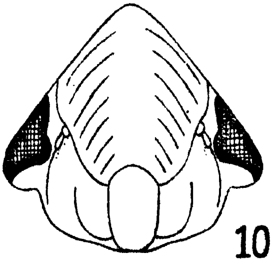

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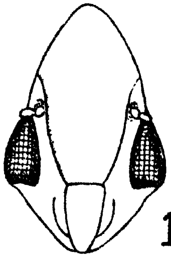

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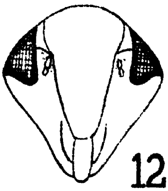

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PLATE IX

Fig. 1.—Head and Prothorax of *Eurinoscopus viridis* (Bythoscopidae).
Fig. 2. Head and Prothorax of *Penthimia americana* (Bythoscopidae).
Fig. 3.—Head and Prothorax of *Reuteriella flavescens* (Bythoscopidae).
Fig. 4.—Head and Prothorax of *Hecalus lineatus* (Bythoscopidae).
Fig. 5.—Head and Prothorax of *Gypona angulata* (Bythoscopidae).
Fig. 6.—Head and Prothorax of *Oncopsis pullus* (Macropsidae).
Fig. 7.—Head and Prothorax of *Rhotidoides norfolkensis* (Thymbridae).
Fig. 8.—Head and Prothorax of *Idiocerus leurensis* (Idioceridae).
Fig. 9.—Head and Prothorax of *Chlorotettix unicolor* (Euscelidae).
Fig. 10.—Head and Prothorax of *Austroagalloides nigra* (Austroagalloididae).
Fig. 11.—Head and Prothorax of *Rubria carnosa* (Ledridae).
Fig. 12.—Head and Prothorax of *Dorycephalus platyrhynchus* .(Ledridae).
Fig. 13.—Head and Prothorax of *Oncometopia suturalis* (Cicadellidae).
Fig. 14.—Head and Prothorax of *Euacanthus acuminatus* (Euacanthidae).
Fig. 15.—Head and Prothorax of *Preta gratiosa* (Signoretidae).

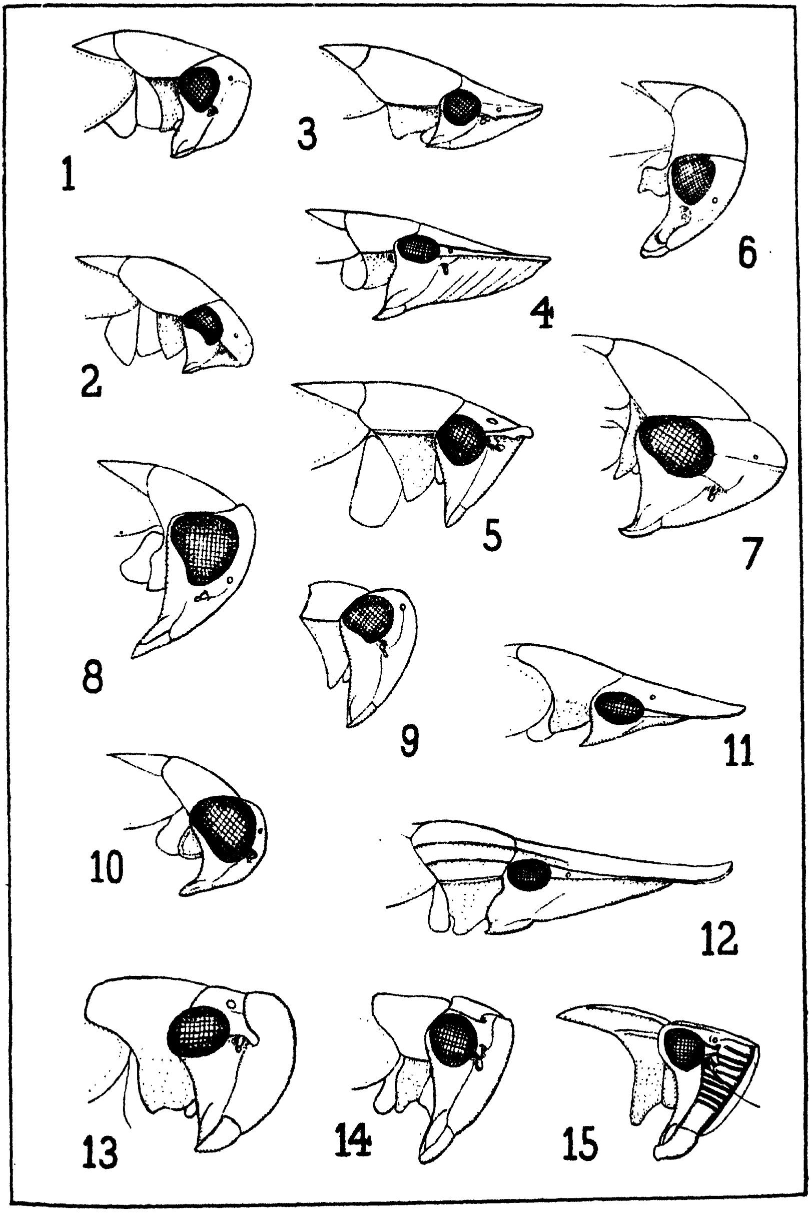
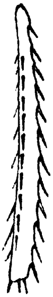


PLATE X

Fig. 1.—Hind Tibia of *Eurinoscopus viridis* (Bythoscopidae).
Fig. 2.—Hind Tibia of *Idiocerus kirkaldyi* (Idioceridae).
Fig. 3.—Hind Tibia of *Macropsis victoriensis* (Macropsidae).
Fig. 4.—Hind Tibia of *Bakeriola procurrens* (Eurymelidae).
Fig. 5.—Hind Tibia of *Eurymelops bicolor* (Eurymelidae).
Fig. 6.—Hind Tibia of *Lasioscopus acmaeops* (Eurymelidae).
Fig. 7.—Hind Tibia of *Tartessus fulvus* (Tartessidae).
Fig. 8.—Hind Tibia of *Rhotidus leurensis* (Thymbridae).
Fig. 9.—Hind Tibia of *Koebelia californica* (Stenocotidae).
Fig. 10.—Hind Tibia of *Aethalion reticulatum* (Aethalionidae).
Fig. 11.—Hind Tibia of *Stenocotis depressa* (Stenocotidae).
Fig. 12.—Hind Tibia of *Macroceps tamarensis* (Thymbridae).
Fig. 13.—Hind Tibia of *Cicadella richmondensis* (Cicadellidae).
Fig. 14.—Hind Tibia of *Rubria sanguinea* (Ledridae).
Fig. 15.—Hind Tibia of *Ledropsis crocina* (Ledridae).
Fig. 16.—Hind Tibia of *Preta gratiosa* (Signoretidae).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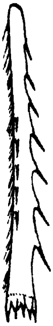
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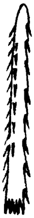
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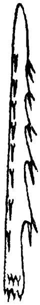
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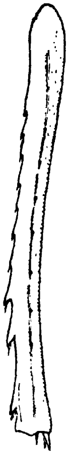
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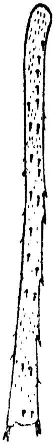
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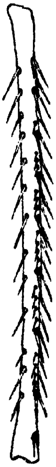
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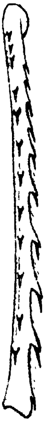
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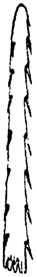
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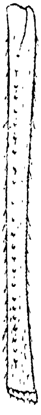
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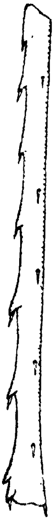
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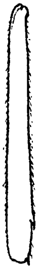
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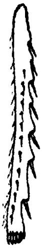
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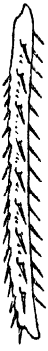
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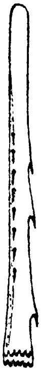
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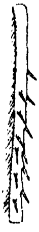
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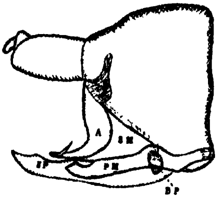
PLATE XI

Fig. 1.—Male Genitalia of *Bakeriola procurrens* (Eurymelidae).
Fig. 2.—Male Genitalia of *Eurymela fenestrata* (Eurymelidae).
Fig. 3.—Male Genitalia of *Eurinoscopus viridis* (Bythoscopidae).
Fig. 4.—Male Genitalia of *Macropsis tasmaniensis* (Macropsidae).
Fig. 5.—Male Genitalia of *Austroagallia torrida* (Agalliidae).
Fig. 6.—Male Genitalia of *Idiocerus kirkaldyi* (Idioceridae).
Fig. 7.—Male Genitalia of *Ledropsis crocina* (Ledridae).
Fig. 8.—Male Genitalia of *Koebelia californica* (Stenocotidae).
Fig. 9.—Male Genitalia of *Smicrotis* sp. (Stenocotidae).
Fig. 10.—Male Genitalia of *Hackeriana glauca* (Thymbridae).
Fig. 11.—Male Genitalia of *Tartessus idyia* (Tartessidae).
Fig. 12.—Male Genitalia of *Euscelis stactogalus* (Euscelidae).

a., aedeagus; sm. segmental membrane; bp., basal plate; sp., sub-genital plate; pm., paramere; pg., pygophore.



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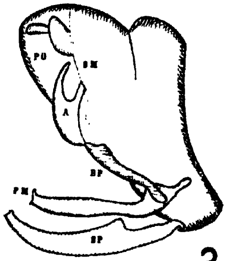

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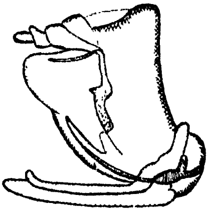

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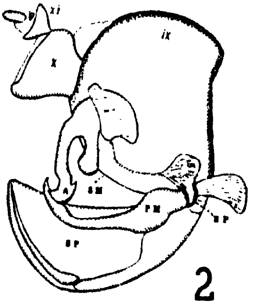

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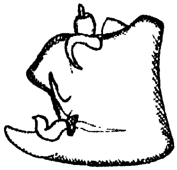

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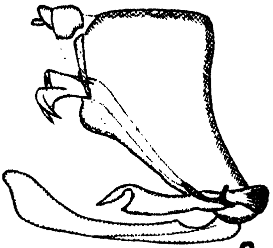

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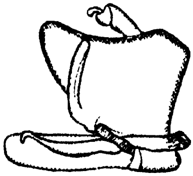

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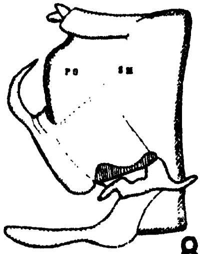

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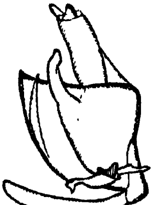

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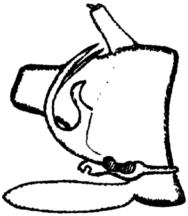

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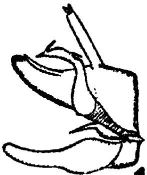

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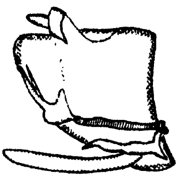

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PAP. & PROC. ROY. SOC. TASMANIA, 1938 (14th March, 1939).

A Second Revision of the Lepidoptera of Tasmania.

By

A. JEFFERIS TURNER, M.D., F.R.E.S.

Twelve years have passed since I attempted a revision of the Tasmanian Lepidoptera.[*] The inception of the Biological Survey of Tasmanian has recalled me to this task. Much new material has been collected, of which most came from three summer visits which I made in 1935, 1937, and 1938, supplemented by a collecting trip made by Mr. G. M. Goldfinch, of Sydney, this year. Unfortunately resident collectors in the island are still very few. I received some specimens from Mr. I. Harman, who resided several years at Snug, near Hobart. Capt. D. C. Pearse has given me valuable assistance, and I have received specimens also from Mr. and Mrs. Davis (G. and C. Davis). Among the older collectors mentioned in my revision, I omitted to mention Mr. A Simson, who reared some interesting species from larvae in the Launceston district.

Altogether these additions have considerably increased our knowledge of the island lepidoptera, and of their range of distribution. Of the butterflies and larger moths our knowledge appears fairly complete. Though new species of the latter are still being discovered, their number is comparatively small. On the other hand, many new microlepidoptera have been added to our list. This section is still imperfectly known, and many new discoveries await the collector. An example of this is the new species of *Phyllocnistis*, recently found in his own garden by Dr. V. V. Hickman, of Hobart University. He has made valuable observations on its life history. Very little has yet been done in the study of the larvae in Tasmania.

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[*] A. JEFFERIS TURNER, 1926.—New and Little-known Tasmanian Lepidoptera. *Pap. Roy. Soc. Tas.*, 1925, pp. 81-117.

———————— 1926.—A Revision of the Lepidoptera of Tasmania. *Pap. Roy. Soc. Tas.*, 1925, pp. 118-151.

————————, 1927.—New and Little-known Tasmanian Lepidoptera, Part II. *Pap. Roy. Soc. Tas.*, 1926, pp. 119-164.

I may mention that an example of the large migratory North American butterfly *Danais archippus* has recently been captured near Launceston. This species is now well established in all the mainland States, the larvae feeding on the introduced weeds *Asclepia curassiva* and *Gomphocarpus fructicosus*. Unless these occur on the island, which is doubtful, the species cannot establish itself here.

This second revision consists of five parts. (1) Omissions and alterations which should be made in the former list. (2) A list of a few species formerly known only from Tasmania, which have since been discovered on the Australian continent. (3) A much longer list of Australian species, which have been taken during the last twelve years in Tasmania. (4) Descriptions of 87 new species and 6 new genera. (5) Additional localities for species included in the original revision.

Omissions and Alterations in Former List

Nymphalidae. Satyrinae

Oreixenica lathoniella Westw.

I have taken the form *laranda* W. & L. at Waratah and Strahan, and am now convinced that it is not a distinct species. It is very near the form I have described as *barnardi,* but the underside of the hindwings is often darker and the basal silvery spots often narrower. On a longer series I believe the two forms would be found to be indistinguishable. Waratah is only separated by 30 miles of elevated land from Cradle Mountain, and if the two forms were genetic races, I do not think they could co-exist. I suggest that the differences result from climatic conditions, probably acting on the larvae; and I am inclined to extend the same explanation to the differences between *barnardi* and the typical *lathoniella.* This hypothesis is open to proof or disproof by breeding experiment.

Hesperidae

For *Padraona* Moore *Ocybadistis* Heron should be substituted. It has recently been shown that two species have been confused under the name *flavovittata* Latr. Of these *O. walkeri* has been taken at Burnie. To which species the other locality records refer is at present doubtful, but it is possible that the true *O. flavovittata* also occurs in Tasmania.

Larentiadae

Poecilasthena aedaea Turn. should be omitted. It is a synonym for *Minoa euthecta* Turn., which should be added to the list.

Microdes typhopa Low. is a South Australian species, and it is doubtful whether it occurs in Tasmania. I suspect there has been an error.

Eccymatoge iopolia Turn. should be transferred to the genus *Poecilasthena.*

Eucymatoge liometopa Turn. is a synonym of *Eccymatoge morphna* Turn., a species that occurs on Australian mountains.

Euphyia bichromata Gn. is an older name for *E. languescens* Rosen.

Acalaphes Turn. I now refer this anomalous genus to the *Boarmiadae.*

Acalyphes philorites Turn. I took four additional male examples in Cradle Valley in February. They were flying rather strongly by daylight on the edges of the beech forest. In spite of the anastomosis of 12 of the hindwings with the cell, I now regard this genus as closely allied to, in fact a development of, *Dirce* Prout. In other respects the neuration of the hindwings is identical for what I took for vein 5 appears to be only a fold of the wing membrane.

Boarmiadae

Ecpatites callipolia Turn. is a synonym of *Mictodoca toxeuta* Meyr.

Oenochromidae

Taxeotis inconcisata Wlk. *T. intextata* Gn. is an older name, and must be substituted.

Arctiadae

Hestiarcha atala Turn. is a synonym of *Thermeola tasmanica* Hmps.

Noctuidae. Agaristinae

Radinocera placodes Low. is a Queensland species. The Tasmanian locality is erroneous.

Acronyctinae

In my opinion the genus *Peripyra* Hmps. should be considered a synonym of *Amphipyra* Ochs.

Ophiderinae. (Noctuinae)

I believe the Tasmanian locality for *Sandava xylistis* to be erroneous; at least it requires verification.

Crambidae

For *Thinasotia* Hb, substitute *Platytes* Gn.

Tortricidae

Tortrix hemiphoena Turn. I now believe to be the same species as *T. eurystropha* Turn. It extends to Queensland. The latter name has priority.

Capua poliobaphes and *C. asemantica.* Having obtained a long series, I am now of opinion that these are one species.

Elachistidae

Labdia autotoma should be transferred to the allied genus *Stagmatophora.*

Gelechiadae

Aristotelia bacillum Turn. is a synonym of *Iulota epispila* Low.

Oecophoridae

Leptocroca silicolor Turn. is a synonym of *Borkhausenia acalles* Turn..

Leptocroca epimicta Meyr. Delete Russell Falls.

Locheutis inconcinna Turn. is a synonym of *Barea arbitra* Meyr

Oenochroa phoenochyta Turn. I have made this the type of the genus *Eucryphaea,* P.L.S.N.S.W., 1935, p. 329.

Barea heterophanes Turn. is a synonym of *B. helica* Meyr.

Barea hypselotropha is a synonym of *Eulechria umbrosa* Meyr.. which is a true *Barea.*

Barea semocausta Meyr. Delete all localities, except Deloraine.

Orescoa Turn. I now merge in the genus *Elaeonoma.*

The following species should be transferred from *Eulechria* to *Macronemata* Meyr., P.L.S.N.S.W., 1883, p. 345 (as defined by myself in P.L.S.N.S.W., 1936, p. 303), *suppletella, textilis, tacita,* and perhaps *paurogramma* (which I have not seen).

Eulechria cirrhopis Turn. should be transferred to *Elaeonoma.*

Eulechria oxypeuces Turn. should be transferred to *Borkhausenia.*

Machaeretis psathyra Meyr. Delete all localities, except Hobart.

Phlobota crepera Meyr. should be transferred to *Eulechria.*

Phlobota ethnitis Meyr. is a synonym of *Eulechria myriospila* Low.

Phlobota pandora Turn. should be transferred to *Chrysonoma.*

Eochrois cirrhophara Turn. should be transferred to *Philobota.*

Sphyrelata ochrophaea should be transferred to *Eulechria.*

Tasmanian Species now Known to Occur on the Australian Continent.

These were marked with an asterisk in the former revision.

Microdes diplodonta Turn., from Ebor, N.S.W.

Amelora cyclocentra Turn., from Mt. Buffalo (4000 ft.), Vic.

Porela subfasciata Turn., from Moe, Vic.

Epipaschia amaurodes Turn., from Mt. Buffalo, Vic.

Tortrix polyphrica Turn., from Mt. Buffalo, Vic.

Carposina latebrosa Meyr., from Southport, Q.

Borkhausenia oxypeuces (Eulechria) Turn., from Beaconsfield, Vic.

Philobota ceratina Meyr., from Mt. Kosciusko (3500 ft.), N.S.W.

Eutorna leptographa Meyr., from Moe, Vic.

Eutorna phaulocosma Meyr., from Mt. Kosciusko (3500 ft.), N.S.W

Australian Species not Recorded in Previous Revision.

Larentiadae

Minoa euthecta Turn. P.R.S., Vic., 1903, p. 243, P.L.S.N.S.W., 1906, p. 697. Allowing for individual differences, Tasmanian examples do not appear distinguishable from those taken in southern Queensland, Russell Falls, Burnie, Rosebery, Strahan. I have also seen an example from Gisborne, Victoria.

Poecilasthena oceanias Meyr. P.L.S.N.S.W., 1890, p. 816. Mt. Wellington (2500 ft.), Weldborough, Burnie, Rosebery, Zeehan.

Eccymatoge morphna Turn. Tr. R.S.S.A., 1922, p. 192. Hobart. Russell Falls, Strahan.

Larentia dascia Turn. P.R.S., Vic., 1903, p. 275. Tasman Peninsula, Coles Bay, Derwent Bridge.

Melitulias oriadelpha Turn. Tr. R.S.S.A., 1926, p. 122. Cradle Mount (3000 ft.).

Euphyia trissocyma Turn. Tr. R.S.S.A., 1922, p. 252. St. Helens (Goldfinch).

Diploctena pantoea Turn. P.L.S.N.S.W., 1907, p. 634. Waratah (Goldfinch).

Geometridae

Pingasa muscosaria Gn., ix, p. 281. Goldfinch, P.L.S.N.S.W., 1929, p. 390. Hobart.

Boarmiadae

Ectropis pristis Meyr. P.L.S.N.S.W., 1891, p. 625. Coles Bay and St. Helens (Goldfinch).

Ectropis aganopa Meyr. P.L.S.N.S.W., 1891, p. 610. Hobart.

Psilosticha integraria Wlk. is the correct name for *P. mactaria* (Meyr. nec Gn.). Hobart, St. Helens.

Boarmia leucoplecta Meyr. P.L.S.N.S.W., 1891, p. 607. Waratah (Goldfinch).

Boarmia chionomera Low. Tr. R.S.A., 1893, p. 159. Russell Falls (Goldfinch).

Boarmia loxographa Turn. P.L.S.N.S.W., 1917, p. 353. Weldborough.

Boarmia atycta Turn. Mr. G. M. Goldfinch informs me that this is synonym of *Psilosticha mactaria* Gn. (nec Meyr.).

Casbia rhodina Turn. Coles Bay (Goldfinch).

Idiodes prionosema Turn. P.L.S.N.S.W., 1919, p. 291. Strahan.

Amelora zophopasta Turn. P.L.S.N.S.W., 1919, p. 301. Hobart.

Chlenias pini Tind. Rec. S.A. Mus.

Oenochromidae

Dichromodes exsignata Wlk. (nec Meyr.), xxiii, p. 1010 (accidentally omitted) (syn. *D. diasemaria* Meyr. P.L.S.N.S.W., 1889, p. 1171). Tasman Peninsula, St. Helens, Beaconsfield, Zeehan, Strahan, Cradle Mountain (3000 ft.).

Notodontidae

Gallaba duplicata Wlk., xxxii, p. 458. Turn. P.L.S.N.S.W., 1903, p. 68. Hobart.

Arctiadae

Calamidia hirta Wlk., ii, p. 510. Meyr. P.L.S.N.S.W., 1886, p. 694. Burnie.

Noctuidae. Acronyctinae

Bathytricha Turn. Tr. R.S.S.A., 1920, p. 150, *truncata* Wlk., ix, p. 111. Launceston.

Caradrina cyanoloma Low. P.L.S.N.S.W., 1902, p. 647. Coles Bay; Devonport.

Caradrina loxosema Turn. Tr. R.S.S.A., 1908, p. 55. Hobart, Cradle Mountain (3000 ft.).

Caradrina porphyrescens Low. P.L.S.N.S.W., 1902, p. 652. Waratah.

Caradrina microspila Low. P.L.S.N.S.W., 1902, p. 648. Deloraine, Devonport.

Hypeninae

Bracharthron Hamps. (Ill. Het., viii, p. 99), *ossicolor* Rosen. Scottsdale, Strahan.

Phycitidae

Crocydopora Meyr. P.L.S.N.S.W., 1882, p. 158, *cinigerella* Wlk., xxxv, p. 1719. Strahan.

Crambidae

Diptychophora dilatella Meyr. P.L.S.N.S.W., 1878, p. 199. Hobart.

Pyralidae

Catamola capnopis Meyr. Tr. E.S., 1885, p. 439. Ulverstone (Goldfinch).

Macalla thyridalis Wlk., xvi, p. 167. Meyr., Tr. E.S., p. 64. Cygnet.

Pyraustidae

Metallarcha Meyr. (Tr. E.S., 1884, p. 331), *diplochrysa* Meyr Tr. R.S., 1884, p. 332. King Island.

Criophthona Meyr. (Tr. E.S., 1884, p. 339), *celaenophaes* Turn. P.R.S.Q., 1912, p. 151. Coles Bay (Goldfinch).

Scoparia crocospila Turn. P.R.S., Vic., 1922, p. 53. Hobart.

Tortricidae

Acropolitis excelsa Meyr. P.L.S.N.S.W., 1910, p. 172. Strahan.

Capua solana Wlk., xxviii, p. 300. Meyr., P.L.S.N.S.W., 1881, p. 476. Weldborough.

Capua leucostacta Meyr., 1910, p. 202. Weldborough.

Tortrix cerussata Meyr. P.L.S.N.S.W., 1910, p. 234. Mt. Wellington (1500-3000 ft.), Waratah.

Epichorista microstictis Meyr. P.L.S.N.S.W., 1910, p. 260. Cradle Mountain (2000 ft.).

Epichorista hyperacria Turn. Tr. R.S.S.A., 1916, p. 515. Cradle Mountain (3000 ft.).

Epichorista leptosticta Turn. Tr. R.S.S.A., 1916, p. 516. Cradle Mountain (3000ft.).

Arotrophora xythopterana Meyr. P.L.S.N.S.W., 1881, p. 529. Derwent Bridge and Waratah (Goldfinch).

Arothrophora ammodes Meyr. P.L.S.N.S.W., 1910, p. 265. Derwent Bridge.

Cnephasia mermera Meyr. P.L.S.N.S.W., 1910, p. 277. Weldborough (Goldfinch). This is the first Tasmanian example I have seen. I now accept Meyrick's locality, Mt. Wellington (3000 ft.).

Cuephasia rupicolana Meyr. P.L.S.N.S.W., 1881, p. 526. Hobart.

Eucosmidae

Spilonota zopherana Meyr. P.L.S.N.S.W., 1881, p. 230. Mt. Barrow (Goldfinch).

Elachistidae

Stagmatophora (H-Sch. Schmet. Eur., v, p. 49), *argyrostrepta*, Meyr. P.L.S.N.S.W., 1897, p. 353. Triabunna (Goldfinch).

Gelechiadae

Megacraspedus sclerotricha Meyr. P.L.S.N.S.W., 1904, p. 279. Hobart.

Phthorimaea xerophylla Meyr. P.L.S.N.S.W., 1904, p. 320. Triabunna (Goldfinch).

Hemiarcha metableta Turn. Tr. R.S.S.A., p. 174. Mt. Wellington (2500 ft.).

Protolechia hormodes Meyr. P.L.S.N.S.W., 1904, p. 363. Hobart.

Xyloryctidae

Xylorycta calligramma Meyr. Tr. R.S.S.A., 1890, p. 64. Hobart (Pearse).

Oecophoridae

Macrobathra anacampta Meyr. Exot. Micro., i, p. 217. Derby.

Artiastis ptochopa Meyr. P.L.S.N.S.W., 1888, p. 1675. Campbell Town.

Borkhausenia hypochalcha Meyr. P.L.S.N.S.W., 1888, p. 782. Hobart, Swansea, St. Marys, Launceston.

Borkhausenia aleurota Meyr. P.L.S.N.S.W., 1885, p. 799. Campbell Town, St. Helens, Launceston, Deloraine.

Barea exarcha Meyr. P.L.S.N.S.W., 1883, p. 357. Burnie.

Eulechria griseola Zel. Lin. Ent., x, p. 151. Meyr., P.L.S.N.S.W., 1882, p. 512. Scottsdale.

Eulechria myriospila Low. Tr. R.S.S.A., 1903, p. 168. Hobart, Mt. Wellington (1500-2500 ft.), Russell Falls, Bothwell, St. Marys, Derwent Bridge, Rosebery. Generally distributed

Eulechria cremnodes Meyr. P.L.S.N.S.W., 1882, p. 154. Derby.

Eulechria convictella Wlk., xxix, p. 566. Meyr., P.L.S.N.S.W., 1882, p. 518. Hobart.

Machimia absumptella Wlk., xxix, p. 567. Meyr., P.L.S.N.S.W., 1882, p. 505. Launceston.

Machimia pudica Zel. Lin. Ent., x, p. 152. Meyr., P.L.S.N.S.W., 1882, p. 500. Hobart.

Machimia carnea Zel. Lin. Ent., x, p. 148. Meyr., P.L.S.N.S.W., 1882, p. 498. Derwent Bridge (Goldfinch).

Thalerotricha mesoplaca Turn. (description will appear in P.L.S.-N.S.W). Mt. Wellington.

Orthiastis Meyr. (Exot. Micro., i, p. 247), *hyperocha* Meyr., P.L.S.-N.S.W., 1884, p. 744. Derwent Bridge.

Coesyra monodyas Meyr. P.L.S.N.S.W., 1884, p. 1047. Cradle Mountain (3000 ft.).

Oxythecta hieroglyphica Meyr. P.L.S.N.S.W., 1884, p. 1052. Coles Bay (Goldfinch).

Pyrgoptila zelotis Meyr., 1902, p. 143. Launceston (A. Simpson). By some mistake attributed to Queensland.

Philobota orthomita Turn. Tr.R.S.S.A., 1917, p. 88. Hobart

Philobota xanthiella Wlk., xxix, p. 693. Meyr., P.L.S.N.S.W., 1883, p. 505. Hobart.

Philobota electrodes Meyr. P.L.S.N.S.W., 1883, p. 512. Hobart (Pearse).

Compsotropha selenias Meyr. P.L.S.N.S.W., 1883, p. 512. Hobart (Pearse).

Eupselia aristonica Meyr. P.L.S.N.S.W., 1880, p. 218. Mt. Wellington (2500 ft.), Cradle Mountain (3000 ft.).

Thudaca mimodora Meyr., 1892, p. 574. Derwent Bridge.

Hyponomeutidae

Zelleria cynetica Meyr. P.L.S.N.S.W., 1892, p. 582. Hobart, St. Helens, Launceston, Deloraine.

Tanaoctena ooptila Turn. P.L.S.N.S.W., 1913, p. 205. Waratah.

Carposinidae

Paratheta aquilana Meyr. P.L.S.N.S.W., 1881, p. 697. Hobart.

Erechthiadae

Opogona nebularis Meyr. P.L.S.N.S.W., 1897, p. 420. Scottsdale.

Tineidae

Mimoscopa ochetaula Meyr. P.L.S.N.S.W., 1892, p. 526. St. Helens (Goldfinch).

Tinea pellionella Lin. Syst. Ent., i, p. 536. Meyr., P.L.S.N.S.W., 1892, p. 535. Hobart (introduced).

Hepialidae

A revision of the Australian genera and species (not yet completed), by Mr. N. B. Tindale, published in the records of the South Australian Museum (1932, 1933, 1935) has greatly added to our knowledge of this family. Many new species have been described, and many changes in the nomenclature have been found necessary. Accordingly, I give here a complete list of the known Tasmanian genera and species.

Trictena Meyr. P.L.S.N.S.W., 1889, p. 1135.

argentata H-Sch. *(labyrinthica).* Lep. Exot, 1853, pl. xi, f. 47, 48. Hobart, Launceston.

Abantiades H-Sch. *(Pielus).* Lep. Exot., i, 1855.

hyalinatus H-Sch. Lep. Exot., i, 1853, pl. xi, f. 50. Hobart, Tasman Peninsula, Launceston.

labyrinthicus Don. Ins. New Hol., 1805, Pl. 38, f. 1. Launceston.

latipennis Tind. Rec. S.A. Mus., 1932, p. 530. Tasman Peninsula, Mt. Wellington (2500 ft.), Derwent Bridge, Zeehan, Launceston, Lake Fenton (3000 ft.).

Oncopera Wlk., vii., p. 1558.

**intricata*[1] Wilk., vii., 1559. Hobart, Maria Island, Swansea, Bothwell, Scottsdale, Cradle Mountain (2000 ft.), Launceston, Wilmot. Generally distributed.

rufobrunnea Tind. Rec. S.A. Mus., 1933, p. 23. Hobart, Fitzgerald, Maria Island, Derwent Bridge, Cradoc.

Jeana Tind. Rec. S.A. Mus., 1935, p. 279.

Two new species are here described.

Oxycanus Wlk., vii, 1573 *(Porina).*

australis Wlk., vii, p. 1574. Launceston, Longford, Sheffield, Maitland, Devonport.

fuscomaculatus Wlk., vii, p. 1574. Hobart, Launceston, George Town, Lefroy, Piper's River.

sordidus H-Sch. Lep. Exot., Pl. 11, f. 49. Hobart, Tasman Peninsula, Launceston.

subvarius Wlk., vii, p. 1562. Ulverstone.

**sphragidias* Meyr. P.L.S.N.S.W., 1889, p. 1123. Launceston, Maitland, Ulverstone, Arthur River, Blackman's Bay.

Fraüs Wlk., vii, p. 1561. *Hectomanes* Meyr. P.L.S.N.S.W., 1889, p. 1125.

simulans Wlk., vii, p. 1564. Hobart, Ross, Launceston.

rufula Turn. P.R.S.Tas., 1926, p. 163. Hobart, Launceston.

pteromela Low. Tr.R.S.S.A., 1892, p. 5. Hobart, Dunalley, Maria Island, Launceston.

**pelagia* Turn. P.R.S.Tas., 1926, p. 164. Strahan.

Charagia Walk., vii, p. 1569.

lignivora Lewin. Prod. Ent., p. 17, Pl. 16. Meyr. P.L.S.-N.S.W., 1889, p. 1129. Hobart, Beaconsfield.

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(1) Species marked with an asterisk have been recorded only from Tasmania.

Descriptions of New Species.

Family LARENTIADAE

Microdes leptobrya, n. sp.

λεπτοβρυος, slightly mossy.

♂♀. 25-30 mm. Head, ochreous-whitish more or less suffused with green and with a few dark fuscous scales. Palpi 3; grey, sprinkled with dark fuscous. Antennae, fuscous; in male, minutely ciliated. Thorax, fuscous, with some green and whitish scales. Abdomen, fuscous; dorsum with whitish transverse bars posteriorly. Legs, fuscous, with whitish rings; posterior pair paler. Forewings triangular, costa moderately arched, apex round-pointed, termen straight to near tornus, scarcely oblique; fuscous, with fine dark fuscous and broader ill-defined whitish-tinged greenish transverse lines; a moderate basal patch limited by a broad green-whitish line, which is strongly outwardly curved; this is edged with dark fuscous and followed by two dark fuscous lines, between which is the dark fuscous discal dot; postmedian line broad, green-whitish, narrowly edged with dark fuscous, from two-thirds costa obliquely outwards, obtusely angled above and below middle, thence curved to before tornus, sometimes interrupted by dark fuscous in middle; a fine sharply defined dentate whitish subterminal line; apices of teeth connected by dark lines with termen; an interrupted dark terminal line; cilia grey, apices whitish, strongly barred with fuscous. Hindwings with termen somewhat produced in middle; whitish-grey; a grey discal dot; a grey terminal band containing a pale dentate line; cilia grey, apices paler.

Waratah, in February; three specimens.

Microdes phricocrossa, n. sp.

φρικοκροσσος, with rippled edge.

♂ 32 mm. ♀ 36 mm. Head, pale grey; face, whitish. Palpi, in male, 2½, in female, 3; dark fuscous, extreme base and apex of second joint and apex of terminal joint, whitish. Antennae, grey; in male dentate and minutely ciliated. Thorax, pale grey; tegulae, whitish with base and subapical bar dark fuscous. Abdomen, grey-whitish. Legs, dark fuscous with whitish rings; posterior pair mostly whitish. Forewings, broadly triangular in male, narrower in female; costa, strongly arched to ¼, thence slightly; apex, rounded-rectangular; termen, slightly rounded, scarcely oblique; 5 from middle of cell or slightly below, whitish with some pale ochreous mottling and sparsely sprinkled with fuscous; markings, dark fuscous; a subcostal linear mark near base; an oblique line from ¼ costa, with a rounded rectangular bend above middle, partly double, ending on dorsum; an imperfect dentate median line; postmedian at ⅔, rounded and rippled, not angled, often resolved into a series of dots on veins, succeeded by a fine whitish line or series of dots, sinuate towards dorsum; a dentate whitish terminal line, preceded and followed by fine longtitudinal streaks on veins; cilia, grey-whitish with narrow dark fuscous bars. Hindwings, with termen strongly rounded; pale grey; an irregular postmedian line of fuscous dots; an irregular whitish subterminal line; cilia as forewings.

Mt. Wellington and Waratah, in February; five specimens received from Mr. G. M. Goldfinch, who has the type.

The genus *Microdes* is confined to Australia and its adjacent island. It contains 10 described species, of which 7 (excluding *M. typhopa*, whose Tasmanian record is doubtful) are found in Tasmania, and of these 5 are peculiar to the island.

Larentia erasta, n. sp.

ἐραστος, charming.

♀. 38 mm. Head and thorax, bright green; apices of tegulae, fuscous. Palpi, 1½, fuscous, inferior edge ochreous-whitish. Antennae, pale fuscous obscurely annulated with whitish. Abdomen on dorsum, pale green with a double series of fuscous dots; lateral margins and underside, grey. Legs, ochreous-whitish sprinkled with fuscous; anterior pair, fuscous with whitish rings. Forewings, broadly triangular; costa, mostly straight, but gently arched near base and apex; apex, subrectangular; termen, slightly rounded, slightly oblique, slightly crenulate, bright green; markings and some irroration dark fuscous, a small basal patch, containing a slender transverse line and bordered by a broader line bent at a right angle above middle and edged with whitish from ¼ costa to ⅓ dorsum; space between this and median band, with some costal dots and two incomplete transverse lines, edged with whitish; median band broad, containing a number of irregularly waved transverse lines, its anterior margin, irregularly dentate and edged with whitish, from ⅓ costa to mid-dorsum; posterior margin with a small subcostal and a more prominent rectangular supra-median tooth, thence inwardly oblique until again angled to end on ⅔ dorsum, whitish-edged; posterior to this several slender whitish lines and some fuscous mottling; subterminal, whitish, crenulate; an interrupted terminal line; cilia, whitish. Hindwings, with termen strongly rounded, slightly dentate; whitish with a series of slender wavy transverse lines; terminal line and cilia as forewings.

This magnificent species is not near any found in Australia, and resembles *L. muscosata* Wlk. from New Zealand, but is considerably larger.

Waratah, in February; one specimen received from Mr. G. M. Goldfinch, who has the type.

Euphyia photographica, n. sp.

φωτογραφικος, like a photograph.

♂. 33-36 mm. Head and thorax, blackish sprinkled with whitish. Palpi, 2, blackish sprinkled with whitish, more whitish beneath. Antennae, blackish; ciliations, in male, ⅓. Abdomen, fuscous mixed with whitish, paired, blackish segmental dots on dorsum. Legs, blackish; tibiae and tarsi with whitish rings; posterior pair sprinkled with whitish. Forewings, broadly triangular; costa, nearly straight to ¾, thence arched; apex, round-pointed; termen, slightly rounded, slightly oblique, blackish, in parts sprinkled with whitish; basal patch ill-defined; median band, mostly whitish in centre, defined by broad blackish lines; first from ⅓ costa to ⅖ dorsum, outwardly curved, wavy, partly edged with whitish anteriorly; second from before ¾ costa to ⅗ dorsum, posteriorly white-edged, indented above middle, with a very strong posterior median tooth, more or less double; a subcostal discal dot in median band; a very fine white crenulate subterminal lines, more distinct on costa; a terminal series of blackish dots; cilia, fuscous, outer half barred with whitish. Hindwings, with termen strongly rounded, dark grey, finely suffused whitish postmedian and subterminal lines; cilia, fuscous; apices, whitish.

The appearance of the forewings, strongly patterned in shades of black and white, irresistibly suggests the name I have given to this species.

Cradle Mountain (3000 feet), in February; two specimens.

Family BOARMIADAE

Psilosticha mactaria Gn.

Lep. ix, p. 270. *Boarmia atycta* Turn.*is a synonym.

Having taken on Mt. Wellington (2500 feet) a second example of this species in much fresher condition, I have thought it advisable to redescribe it.

♀. 44-46 mm. Head and thorax, white sprinkled with blackish. Antennae, grey-whitish with fine blackish annulations. Palpi, 1½; white sprinkled with blackish. Abdomen, white sprinkled with blackish; small paired blackish segmental dots on dorsum. Legs, white; tibiae and tarsi with blackish rings; anterior pair mostly fuscous. Forewings, broadly triangular; costa, straight, except at extremities; apex, round-pointed; termen, moderately rounded, slightly oblique; 10 and 11 long-stalked, 10 anastomosing with 9; white with blackish markings and irroration, appearing whitish-grey; a sub-basal costal spot; an oblique transverse line at ¼, angled beneath costa, closely followed by a parallel dotted line; a similar fine crenulate median line from midcosta to ⅔ dorsum, closely preceded by a subcostal discal dot; a third fine crenulate dotted line from ⅔ costa joining median line below middle; closely following this a suffused grey line; a dentate white subterminal line preceded and followed by a grey suffusion; a terminal series of dots; cilia, whitish-grey, bases barred with blackish. Hindwings, with termen slightly rounded, dentate; colour and markings as forewings, but lines, except subterminal, becoming undefined towards costa. Underside, whitish, sparsely sprinkled with fuscous; a blackish discal dot on each wing.

Casbia crataea, n. sp.

κραταιος, stout.

♂. 36 mm. Head, brown-whitish; face. fuscous. Palpi. 1; whitish-brown, bases of first and second segments, fuscous. Antennae, whitish-brown (pectinations 6 near base, remainder broken off). Thorax, whitish-brown mixed with fuscous; two dark fuscous posterior dots. Abdomen, brown-whitish with some fuscous irroration towards base of dorsum. Legs, whitish-brown marbled with fuscous. Forewings, broadly triangular; costa, strongly arched to ¼, thence straight; apex, rectangular; termen, rounded, slightly oblique crenulate; whitish-brown sprinkled with fuscous, more densely in median area, fuscous strigulae towards termen; basal area paler, edged by a broad outwardly-curved fuscous line from ¼ costa to ¼ dorsum; a blackish median discal dot, immediately preceded by a fuscous line to mid-dorsum, not reaching costa; a tolerably straight fuscous line from costa before apex to ⅔ dorsum, immediately succeeded by a narrow whitish-brown shade, which is crossed by fine short, white streaks on veins 1, 2, 3, 4, each ending in a fuscous dot; cilia, fuscous. Hindwings with termen only slightly rounded; costal, half crenulate, brown-whitish, irroration and strigulae less dense than on forewings; a small blackish discal dot; antemedian and postmedian transverse lines, the latter succeeded by fine, short, white streaks on veins 2, 3, 4, 6, between them some reddish-brown scales, and at their apices fuscous dots; cilia, fuscous.

Larger and more stoutly built than *C. eccentritis*, distinguished by the peculiar postmedian markings and crenulate termen of both wings.

Strahan, in January; one specimen.

Casbia rhodosceles, n. sp.

ῥσδοσκελης, rosy-legged.

♂. 34-36 mm. Head, grey-whitish, more or less pinkish-tinged. Palpi, 1½, crimson mixed with whitish-ochreous. Antennae, grey; pectinations in male extremely long, only extreme apex simple. Thorax, grey; a pair of blackish dots close to its posterior apex. Abdomen, whitish-grey. Legs, whitish-ochreous sprinkled with dark fuscous; anterior coxae and anterior and middle femora, crimson, similarly sprinkled; anterior and middle tibiae mostly fuscous. Forewings, broadly triangular; costa, straight, except near base and apex, apex, acute, termen, straight, rounded beneath, slightly oblique; 7, 8, 9, 10 stalked, 11 from cell anastomosing with 12 (3♂); grey-whitish, more or less suffused with grey; costal, edge strigulated with fuscous, often crimson towards base; three transverse fuscous lines, often partly reddish; first at ¼, outwardly curved, dentate; second median, slightly curved, rather suffused; third at ¾, sinuate, suffused or dentate; a dark fuscous subcostal discal dot on second line; a dentate fuscous subterminal line more or less developed, preceded by two whitish dots about middle, curved inwards above dorsum; a terminal series of dark fuscous dots; cilia, grey, sometimes pinkish-tinged, sometimes with a basal series of whitish dots. Hindwings with apex rectangular; termen, nearly straight, slightly crenulate; pale grey with fine whitish strigulae; a median fuscous discal dot; terminal dots and cilia, as forewings.

Mt. Wellington, in February; three specimens.

Family NOLIDAE

Gen. **Nestiodes**, nov.

νηστιωδης, apparently fasting.

Tongue, absent. Palpi, short, porrect, obtuse. Forewings, with 2 from ¾, 3 from angle, 4 from shortly above angle, 5 from below middle of cell, 6 from upper angle, 9 absent, 7, 8, 10 stalked, 7 separating before 10. Hindwings, with 4 absent, 6 and 7 stalked, 12 anastomosing with cell to beyond middle.

A development of *Nola*, from which it differs in the short palpi and absence of tongue.

Nestiodes eremnopa, n. sp.

ἐρεμνωπος, like a fortification.

♂♀. 17 mm. Head and thorax, white with some dark fuscous scales. Palpi, 1; grey or whitish. Antennae, whitish-grey; in male evenly ciliated, ciliations in male ½. Abdomen, whitish. Legs, whitish sprinkled with fuscous. Forewings, triangular; costa, straight to ¾, thence arched; apex, obtusely pointed; termen, nearly straight, oblique; white; markings and some irroration dark fuscous; two or three sub-basal tufts towards costa; a sub-dorsal dot at ⅓, from which an interrupted line angled outwardly runs to ¼ costa; two nearly parallel fine dentate lines, first from mid-dorsum to costa, second from mid-costa to dorsum, in the male the intermediate space is filled with irroration to form a fascia; a subterminal fascia strongly indented above middle, narrowed into a slender line before ending on tornus; a white line edges this posteriorly; a terminal line thickened into small apical and subapical blotches; cilia, fuscous. Hindwing and cilia, pale grey.

Mt. Wellington (2500 feet), in February, also from Ebor (4000 feet), New South Wales, in January. My type is the female from Ebor.

Nola plagioschema, n. sp.

πλαγιοσχημος, with oblique pattern.

♂. 20 mm. Head and thorax, white. Palpi, 4, laterally compressed, with rough projecting scales beneath; upper edge and inner surface whitish, outer surface fuscous. Antennae, grey; in male with tufts of moderately long cilia (1½). Abdomen, pale grey; tuft, grey-whitish. Legs, whitish; anterior pair, fuscous with whitish tarsal rings. Forewings, elongate-triangular; costa, slightly arched; apex, pointed; termen, nearly straight, oblique, fuscous largely suffused with whitish; a lark fuscous tuft beneath costa near base; a slender dark fuscous line from midcosta to ¼ dorsum, sharply angled inwards and then outwards near dorsum, with two tufts of raised scales beneath costa; a second line from ¾ costa to ⅗ dorsum, similar but almost straight, white-edged posteriorly, angled inwards just above dorsum; a series of short, dark fuscous longitudinal streaks forming a slightly inwardly-curved line from apex to tornus; cilia, fuscous with whitish bars. Hindwings and cilia, pale grey.

Russell Falls and Waratah, in February; two specimens.

Family NOCTUIDAE

Dasygaster eutycta, n. sp.

ἐυτυκτος, well-wrought.

♂. 38 mm. Head and thorax, fuscous. Palpi, 1½; second joint ascending, densely rough-scaled; terminal joint short, porrect, obtuse; fuscous, terminal joint, apex of second joint, and inner surface whitish. Antennae, grey-whitish; in male shortly bipectinate (1) with lateral and terminal ciliations. Abdomen, fuscous; basal and terminal segments grey on dorsum. Legs, fuscous; tarsi and posterior pair paler. Forewings, elongate-triangular; costa, straight; apex, obtusely pointed; termen, slightly rounded, slightly oblique, fuscous; markings, blackish, partly outlined with whitish; a median basal spot; a pait of costal dots near base; a sub-basal dorsal spot; a slender whitish line from ¼ costa to mid-dorsum, with an anterior tooth above dorsum, preceded and followed by a costal dot; a spot touching middle of this line, followed by a narrow white loop representing claviform; orbicular, circular, white-ringed; reniform, similar, but transversely oblong; a slender whitish line from ¾ costa to ⅔ dorsum, preceded by a series of triangular dots, that above dorsum larger and produced to claviform; a terminal series of elongate spots; cilia, whitish. Hindwings with termen gently rounded, grey; cilia, whitish.

Coles Bay, in February; one specimen received from Mr. G. M. Goldfinch, who has the type.

Dasygaster eudmeta, n. sp.

εὔδμητος, well fashioned.

♂♀. 34-40 mm. Head, fuscous, more or less sprinkled with white. Palpi, 2, fuscous, anteriorly brown-whitish. Antennae, fuscous; in male with fascicles of cilia (1). Thorax, white, mixed with fuscous; two anterior fuscous lines sometimes followed by a brown line; dark fuscous submarginal lines on tegulae. Abdomen, grey. Legs, grey; anterior and middle tarsi, fuscous with white rings. Forewings, narrowly triangular; costa, straight; apex, rounded; termen, slightly rounded, scarcely oblique; white, mostly suffused with grey, and sometimes partly with brownish; median area darker; lines blackish; a median streak from base to ⅓; a strigula from costa near base; a very strongly dentate line from ¼ costa to ⅖ dorsum, orbicular narrow, obliquely elongate, white with grey centre; reniform similar, but broadly oval and transverse; postmedian line from ⅔ costa obliquely outwards, sharply bent beneath costa, thence sharply dentate and excavated above and beneath middle, ending on ⅔ dorsum; a broad pale shade from apex to tornus, distinctly outlined, with two strong teeth below middle reaching termen; a terminal series of small fuscous lunules; cilia, fuscous with narrow white bars. Hindwings, with termen wavy, dark grey; cilia, white with grey basal line.

Waratah, in February; plentiful at light.

Caradrina metableta, n. sp.

μεταβλητος, variable.

♂ ♀. 32-36 mm. Head and thorax, fuscous-grey, sometimes brownish-tinged. Palpi, 1⅓, fuscous; terminal joint and apex and lower edge of second joint brown-whitish. Antennae, grey or fuscous, often paler towards base; in male with fascicles of cilia (1). Abdomen, grey. Legs, fuscous-grey or brownish-grey with pale rings. Forewings, narrowly triangular; costa, almost straight; apex, rounded; termen, straight, rounded beneath, not oblique; grey or fuscous in female usually brownish; in male usually a fine blackish median streak from base, but this is absent in female; a very fine dentate fuscous line from ⅓ costa to ⅖ dorsum, often obsolete; orbicular and reniform, ochreous-whitish, the former circular, minute, the latter usually quadrangular with a slight process at posterior inferior angle, sometimes partly bisected by a dark streak from inferior edge; a fine fuscous line from ⅗ costa, outwardly oblique, then bent downwards beyond reniform, and dentate to ⅔ dorsum, often obsolete; a dark subterminal shade, its posterior edge wavy and well defined, sometimes partly dark fuscous or containing some longitudinal dark streaks above middle, sometimes a fine interrupted fuscous terminal line; cilia, grey, bases sometimes ochreous-whitish. Hindwings, with termen rounded, grey; cilia, grey.

Apparently nearest *C. tortisigna* Wlk., but without pale costal streak and terminal band.

Waratah, in February; plentiful at light.

Hypenodes capnophanes, n. sp.

καπνοφανης, dusky.

♂. 16-18 mm. Head, thorax, abdomen, and legs, fuscous. Palpi, with second joint extremely long, porrect, thickened with scales throughout, slightly rough above and beneath; terminal joint short, obliquely ascending, acute, fuscous. Antennae, fuscous; ciliations in male 1½. Forewings, narrowly triangular; costa, slightly arched near base, thence straight to near apex, where it is again arched; apex, pointed; termen, sinuate, slightly oblique, dark fuscous; markings, white; three or four minute dots on apical ¼ of costa; an oblique line from beneath ¾ costa to ⅗ dorsum, interrupted below middle; the upper portion preceded by a blackish suffusion; a very fine sinuate subterminal line not reaching costa; cilia, fuscous. Hindwings, broad; termen, sinuate, grey; cilia, grey.

Vein 9 is absent in the forewing. In this it differs from Meyrick's definition (Revision Handbook. Brit. Lep., p. 165), but this figure of *H. costistrigalis* Steph. shows that this vein separates very near margin. Hampson (Moths Ind. III, p. 98) describes a species from Ceylon with 9 absent.

Mt. Wellington (1500-2500 feet), in January and February; two specimens.

Family CRAMBIDAE

Platytes platysticha, n. sp.

πλατυστιχος, broad-lined.

♂. 23 mm. Head, ochreous-whitish. Labial papli, 5, fuscous. Maxillary palpi, whitish. Antennae, fuscous; ciliations in male minute. Thorax, ochreous-whitish; tegulae and underside, fuscous; pectus, whitish. (Abdomen missing.) Legs, ochreous-whitish; anterior pair, fuscous anteriorly. Forewings, narrow, posteriorly dilated; costa, straight to ⅔, thence gently arched; apex round-pointed; termen, slightly oblique, ochreous-whitish with fuscous longitudinal streaks; a narrow costal streak to ⅔; a broad streak along fold to middle; a median streak commencing as a fine line at

⅙, soon broadening and continued to costa, just before apex, its apical portion divided into three fine parallel lines; five short interneural streaks between this and dorsum; a series of six elongate interneural marks running into termen, the five lower connected with the preceding streaks by fine irroration; cilia, whitish with a broad, grey sub-basal line. Hindwings and cilia, whitish.

Russell Falls, in February; one specimen received from Mr. G. M. Goldfinch, who has the type.

Family TORTICIDAE

Capua euryphaea, n. sp.

εὐρυφαιος, broadly fuscous.

♀. 14 mm. Head, ochreous-whitish. Palpi, 2, whitish, lower edge, fuscous. Antennae, fuscous. Thorax, ochreous-whitish with some fuscous scales. (Abdomen missing.) Legs, fuscous with whitish rings; posterior pair whitish. Forewings, moderately dilated; costa, slightly arched; apex, rounded-rectangular; termen, slightly oblique, ochreous-whitish; markings, dark fuscous, sharply defined; several costal strigulae; a broad basal dorsal blotch reaching more than half across disc, confluent with middle of median fascia, which is narrow on ⅓ costa, but broadens to extend almost to tornus, leaving a white spot on dorsum between it and dorsal blotch; a costal triangle from middle to ⅚; some fuscous irroration on termen; cilia, ochreous-whitish, towards apex mixed with fuscouse. Hindwings, pale grey; cilia, whitish.

Scottsdale, in January; one specimen.

Capua ochrobaphes, n. sp.

ὠχροβαφης, pale.

♂. 13 mm. Head and thorax, ochreous-whitish. Palpi, 1¾, ochreous-whitish, lower edge, fuscous. Antennae, pale grey; ciliations in male, ½. Abdomen, grey; tuft, grey-whitish. Legs, fuscous with whitish rings; posterior pair mostly whitish. Forewings, slightly dilated; costa rather strongly arched; apex, subrectangular: termen, slightly oblique, ochreous-whitish; costa, with short, fuscous strigulae, a suffused fuscous streak, broad at base, from costa near apex curved inwards above middle of disc and extended longitudinally to before ½; an incomplete submarginal line of minute fuscous dots; cilia, ochreous-whitish, bases, except at tornus, fuscous. Hindwings, pale grey; cilia, whitish with a pale grey sub-basal line.

Burnie, in February; one specimen.

Tortrix adoxodes, n. sp.

ἀδοξωδης, obscure.

♂. 14-16 mm. Head and thorax, dark fuscous, more or less sprinkled with reddish. Palpi, 1½, brownish. Antennae, fuscous; in male with tufts of rather long cilia (1½). Abdomen, dark fuscous. Legs, fuscous with whitish tarsal rings. Forewings, sub-oblong; costa moderately arched; apex, rectangular; termen, straight, scarcely oblique; in male a narrow costal fold reaching ⅓, its posterior portion dilated by long whitish scales; dark fuscous with patchy reddish irroration; markings, indefinite, consisting mainly of obscure transverse darker and lighter striae; three whitish striae on midcosta coalescing to form a short ill-defined very oblique pale streak; cilia, fuscous. Hindwings and cilia, fuscous.

Waratah, in February; five specimens.

Tortrix phaeosticha, n. sp.

φαιοστιχος, with dark streaks.

♂ ♀. 18-23 mm. Head and thorax, reddish-brown. Palpi, 2½, brownish. Antennae, pale ochreous-brown; ciliations in male 1. Abdomen, pale grey. Legs, reddish-fuscous; posterior pair mostly whitish. Forewings, sub-oblong; costa, strongly arched, especially towards base; apex, rectangular; termen, faintly sinuate, rounded beneath; in male with a very narrow fold reaching to ⅖; pale ochreous, margins and most veins usually reddish-fuscous; a conspicuous boomerang-curved streak from base along upper margin of cell; a broad dorsal streak containing some paler suffusion; fold and a narrow costal patch from middle to near apex, dark; more or less dark suffusion on terminal area, but veins always darker, subcostal and central areas, together with continuation to apex, pale; cilia, whitish with a fine fuscous sub-basal line. Hindwings, pale grey with faintly darker strigulae; cilia, grey-whitish.

In coloration this approaches *T. postvittana*, but is very distinct in pattern from any of the variations of that species.

Mt. Wellington, St. Helens, Wilmot, Waratah, Rosebery, Strahan, and Weldborough, in January and February; eleven specimens.

Tortrix technica, n. sp.

τεχνικος, artistic.

♂ ♀. 16-20 mm. Head, white. Palpi, 1¾, fuscous. Antennae, fuscous; ciliations in male, ⅔. Thorax, fuscous with a white anterior spot. Abdomen, pale grey; tuft, whitish. Legs, fuscous; posterior pair, whitish. Forewings, sub-oblong; costa, strongly arched in basal half, thence nearly straight; apex, obtusely angled; termen, straight, oblique, rounded beneath; in male with a very narrow costal fold reaching to ⅓, a small triangular tuft of scales on its apical portion; white with some pale grey suffusion towards base and dorsum; markings, dark fuscous, sharply outlined; two short, broad streaks from base, the upper reaching a broad line from costa near base to ⅓ dorsum; an outwardly-oblique line from ⅓ costa, sharply angled in mid-disc and continued to termen beneath apex, there expanded and connected by two fine lines to apex and costa shortly before; an irregular blotch on dorsum before tornus, sometimes connected with previous line; cilia, white, sometimes partly grey beneath apex. Hindwings, pale grey; cilia, whitish.

Closely allied to *T. oriarcha* Meyr., from the Australian Alps.

Waratah, in January and February; locally abundant.

Tortrix oresigona, n. sp.

ὀρεσιγονος, mountain-born.

♂. 18-20 mm. Head, fuscous. Palpi, 2, fuscous. Antennae, fuscous; in male with tufts of moderately long cilia (1). Thorax, fuscous, sometimes with a few whitish scales. Abdomen, grey; tuft, paler. Legs, fuscous with whitish rings; posterior pair, whitish-grey. Forewings, sub-oblong; costa, moderately arched to middle, thence straight; apex, obtusely angled; termen, straight, slightly oblique; whitish suffused with pale grey; markings, dark grey edged with fuscous; a moderate basal patch, containing some whitish scales, near base, its outer edge from ¼ costa to fold, where it is bent outwards, thence downwards to ⅓ dorsum; central fascia, oblique from well before middle, ceasing abruptly in mid-disc, there enlarged and produced upwards to approach or joint costal patch, which is narrow and extends from ⅔ costa nearly to apex; a broad, triangular tornal patch; a circular spot on midtermen, sometimes touching dorsal patch, or prolonged on termen to apex; cilia, fuscous. Hindwings, with termen sinuate, grey with some darker striae; cilia, grey-whitish with a darker basal line.

Nearest *T. euraphodes* Turn., from Mt. Kosciusko.

Mt. Wellington (4000 feet), in January; locally common.

Tortrix campylosticha, n. sp.

καμπυλοστιχος, with bent lines.

♂♀. 20-22 mm. Head, pale ochreous or whitish. Palpi, 2¼, fuscous, upper edge pale ochreous or whitish. Thorax, dark fuscous with a postmedian white transverse line. Abdomen, ochreous, towards base grey. Legs, fuscous; posterior pair, ochreous. Forewings, sub-oblong; costa, arched to middle, thence straight; apex, obtusely angled; termen straight, slightly oblique; in male without coastal fold; white with dark fuscous angular fuscous lines and marginal dots; a rather broad sub-basal line; another from ⅓ costa to ¼ dorsum, angled outwards in middle, and inwards below this, rarely interrupted; a third from before midcosta, often constricted or interrupted above middle, angled outwards beneath costa, often incomplete or divided above dorsum, on which it may be represented by one or two dots; costal dots between this and following lines; an oblique line from ¾ costa to termen below middle, usually bifurcate on costa; an irregular erect line from tornus; a terminal series of confluent dots; cilia, white, bases suffused or barred with fuscous. Hindwings and cilia, ochreous.

This is the Tasmanian representative of *T. amoenana* Meyr., but it appears sufficiently distinct for specific separation.

Cradle Mountain (2000-3000 feet), Waratah, and Derwent Bridge, in January and February; locally common.

Tortrix haplopolia, n. sp.

ἁπλοπολιος, simple grey.

♂. 18-20 mm. Head and thorax, grey. Palpi, 2, grey. Antennae, grey, annulated with blackish; ciliations in male (1), Abdomen, pale grey; tuft, whitish. Legs, whitish; anterior pair, fuscous. Forewings, sub-oblong; costa, strongly arched; apex, rectangular; termen, straight, rounded beneath, scarcely oblique; in male with a very narrow rudimentary costal fold to about middle; grey with numerous fine fuscous strigulae tending to form wavy transverse lines; cilia, grey. Hindwings, with termen sinuate, whitish coarsely strigulated with grey; cilia, pale grey.

Mt. Wellington (2500 feet) and Waratah, in February; six specimens.

Tortrix flebilis, n. sp.

flebilis, mournful.

♂. 16-20 mm. Head, grey. Palpi, 2, fuscous, inner surface and upper edge whitish. Antennae, grey; ciliations in male (1). Thorax, fuscous. Abdomen, grey. Legs, fuscous; posterior pair whitish. Forewings somewhat dilated posteriorly; costa, strongly arched to ⅓, thence straight; apex, pointed; termen, straight, oblique; in male without costal fold; fuscous more or less sprinkled with reddish; sometimes a broad whitish streak strigulated with reddish and grey on dorsum and continued round tornus (in two examples), but this is usually completely absent; no defined markings, but usually a darker oblique streak from middle of disc to tornus and ill-defined and variable longitudinal streaks in disc; cilia, white with a reddish or grey basal line. Hindwings, grey with obscure darker strigulae; cilia, white with grey basal line.

The form of variation is curious.

Waratah, in January and February; five specimens.

Tortrix leuropa, n. sp.

χευρωπος, smooth.

♂. 17 mm. ♀. 22 mm. Head and thorax, dark grey. Palpi, in male 2½, in female, 3, pale grey reddish-tinged. Antennae, grey; ciliations in male (1). Abdomen, whitish-grey. Legs, grey-whitish. Forewings, sub-oblong; costa, strongly arched, especially towards base; apex, subrectangular; termen, sinuate, slightly oblique; in male without costal fold; pale reddish-grey, in male with scattered blackish dots; an elongate mark on ¼ dorsum fuscous mixed with reddish; a variable fuscous or reddish patch on ¾ dorsum; two or three blackish dots on tornus; cilia, ochreous-whitish, reddish-tinged near apex of wing. Hindwings, pale grey with distinct darker strigulae; cilia, whitish.

Probably allied to *T. oressinoma* Turn.

Scottsdale, in January; two specimens.

Tortrix antilecta, n. sp.

ἀντιλεκτος, questionable.

♂. 18-20 mm. Head and thorax, grey. Palpi, 2, grey. Antennae, grey; ciliations in male ⅔. Abdomen, grey, tuft, ochreous-whitish. Legs, fuscous; posterior pair, ochreous-whitish. Forewings, sub-oblong, not dilated; costa, rather strongly arched; apex, rectangular; termen, straight, rounded beneath, hardly oblique; male with a very slender costal fold to ⅓, with a smaller triangular tuft of scales before its end; whitish-grey, more or less strigulated with darker grey, in some examples scantily sprinkled with pale ochreous in parts; markings, fuscous; a basal costal dot and tuft on costal fold, fuscous; sometimes a series of costal dots; a fine interrupted line from ⅗ costa to ⅔ dorsum more or less developed; sometimes a short inwardly oblique line from ⅓ costa to mid-disc, but this is usually reduced to one or two dots, and may be wholly absent; cilia, grey-whitish. Hindwings and cilia, grey-whitish.

A variable species. In some examples the markings are much reduced, and in one completely absent.

Waratah, in January and February, Rosebery, in February; five specimens. Also two from Sydney, in October (G. M. Goldfinch). My type is from Waratah.

Arotrophora pantoeodes, n. sp.

παντοιωδης, variable.

Arotrophora castanea Turn. Proc. Roy. Soc. Tas., 1926, p. 132, nec Meyr.

Although I have not seen an authentic example of Meyrick's species, I am now satisfied that it is distinct from that which I have fully described.

Mt. Wellington (2500 feet), Lake Fenton, and Derwent Bridge, in January.

Family EUCOSMIDAE

Laspeyresia argyrocyrta, n. sp.

ἀργυροκυρτος, with silvery curve.

♀. 13 mm. Head, thorax, and abdomen, fuscous. Palpi, 2, whitish; terminal joint, except apex, fuscous. Antennae, fuscous. Legs, fuscous; posterior pair, paler. Forewings, sub-oblong; costa, gently arched; apex, rounded-rectangular; termen, nearly straight, slightly oblique, fuscous; a broad, oblique, outwardly-curved, white bar from mid-dorsum to middle of disc; costa with alternate dark fuscous and whitish streaks, metallic at apices, from ¼ almost to apex, dark streaks, all short, the first four outwardly oblique; first and second pale streaks short, each bisected on costa by a dark fuscous dot; third similarly bisected on costa, prolonged as an evenly curved metallic line to tornus, at first violet-metallic, then broadened and silvery; fourth short; fifth rather longer; sixth long, and bent outwards to touch apex of ninth, which is also long; seventh and eighth very short; four longitudinal black lines between lower half of termen and third streak; cilia, fuscous. Hindwings and cilia, fuscous.

There are several nearly allied Australian species.

Tasman Peninsula, in January; one specimen.

Family ELACHISTIDAE

Labdia apenthes, n. sp.

ἀπενθης, cheerful.

♂. 9 mm. Head, white. Palpi, white; both second and third terminal joints with basal and subapical blackish rings. Antennae, blackish with white annulations. Thorax, dark fuscous. Abdomen, fuscous; tuft, grey-whitish. Legs, fuscous with white rings. Forewings, narrow; apex, rounded; a small grey basal patch with blackish median and dorsal marginal dots; white costal spots at ¼, ½, and ¾; between these blackish costal spots at ⅓ and ⅔, and another at apex; dorsal area, grey; a triangular blackish median spot nearly touching apex of first blackish spot on costa; a white line from tornus nearly reaching third white costal spot; cilia, whitish-ochreous, on dorsum, grey. Hindwings, linear-lanceolate, grey; cilia, 5, grey.

Allied to *L. niphostephes* Turn., from which it may be best distinguished by the fuscous thorax.

Hobart, in January; one specimen received from Capt. D. C. Pearse.

Labdia auchmerodes, n. sp.

αὐμηρωδης, dusty.

♀. 10 mm. Head, thorax, and abdomen, grey. Palpi, blackish, second joint with basal and median, terminal joint with basal, median, and subapical white rings. Antennae, grey. Legs, dark fuscous with white rings. Forewings, narrow; apex, round-pointed, whitish-grey; markings, fuscous, not sharply defined; three dots in an oblique line, first on costa near base, second above fold, third between fold and ⅓ dorsum; two transverse fasciae at ¼ and middle; a fine median streak from ¾ to apex; cilia, grey. Hindwings, narrow-lanceolate; cilia, 5, grey; cilia, grey.

Hobart, in January; one specimen.

Trachydora oxypeuces, n. sp.

ὀξυπευκης, sharp-pointed.

♂. 24 mm. Head, grey-whitish. Palpi, with second joint dilated at apex forming a short triangular anterior tuft, grey; terminal joint whitish with three fuscous rings. Antennae, grey. Thorax, grey-whitish, anterior and lateral margins blackish. Abdomen, grey; dorsum of second and third segments brownish with fuscous median line. Legs, pale grey. Forewings, lanceolate; apex, acute; grey-whitish with blackish longitudinal line and some irroration towards costa; a fine subcostal streak from base to ¼, a median streak from base to apex, thickened in middle portion, slender towards each end; beneath this a narrow grey suffusion; a line along fold to middle bearing several prominent crests; a white apical dot; cilia, grey. Hindwings, narrow-lanceolate, grey; cilia, grey.

Rosebery, in January; one specimen.

Microcolona polygethes, n. sp.

πολυγηθης, delightful.

♂. 10 mm. Head and thorax, grey. Palpi, white with three blackish rings, apical on second joint, sub-basal and subapical on terminal joint. Antennae, white annulated with blackish. (Abdomen missing.) Legs, grey on dorsal, white on ventral surface. Forewings, narrow; grey suffused with pale ochreous, except on costal margin; markings, black; a minute dot on fold near base; first discal at ⅖, white-edged, plical beneath it, larger, second discal at ⅘, crescentic or double; a series of minute dots on apical third of costa and on termen; cilia, fuscous, on dorsum, grey. Hindwings, linear-lanceolate, grey; cilia, 6, grey.

Tasman Peninsula, in January; one specimen.

Batrachedra notocapna, n. sp.

νωτοκαπνος, smoky-backed.

♀. 14 mm. Head, white; centre of crown whitish-grey. Palpi with slight angular projection on apex of second joint; white, median, and subapical rings on second joint and one on apex of terminal joint, blackish. Antennae, grey. Thorax, whitish-grey in centre, broadly white on sides. Abdomen and legs, whitish. Forewings very narrow; apex, acute, white, sparsely but fairly uniformly sprinkled with fuscous; a rather broad but not distinctly defined dorsal fuscous streak from base, gradually attenuating to about ⅔; cilia, pale grey. Hindwings, linear-lanceolate, pale grey; cilia, 6, pale grey.

Hobart, in January; one specimen received from Capt. D. C. Pearse.

Scythris albipuncta, n. sp.

albipunctus, with white dots.

♂. 12 mm. Head, palpi, thorax, and abdomen, dark fuscous with bronzy reflections. Antennae, fuscous; in male shortly ciliated (½). Legs, fuscous. Forewings, narrow; apex, rounded, dark fuscous with bronzy reflections; stigmata, white, minute, first discal at ⅖, plical slightly beyond it, second discal at ⅗; a white spot on tornus; a white subapical dot; cilia, fuscous, on dorsum, grey. Hindwings, narrow lanceolate, cilia, 6, both grey.

Burnie, in January; one specimen.

Fam. GELECHIADAE

Iulota ochropolia, n. sp.

ὠχροπολιος, pale grey.

♀. 12 mm. Head and thorax, pale grey. Palpi, grey; apex of terminal joint whitish. Antennae, whitish annulated with dark fuscous. (Abdomen missing). Legs, grey-whitish; posterior pair, white. Forewings, lanceolate, whitish finely sprinkled with pale grey; cilia, whitish, on apex, grey. Hindwings and cilia, pale grey.

Allied to *I. phauloptila* Turn. from Mt. Kosciusko.

Strahan, in January; one specimen.

Aristotelia aphthoropa, n. sp.

αφθορωπος, chaste.

♂. 12-13 mm. Head, thorax, and abdomen, grey-whitish. Palpi, with second joint reaching base of antennae, rough anteriorly, terminal joint ⅗, grey-whitish; apex of terminal joint whitish. Antennae, grey-whitish; ciliations of male minute. Legs, whitish. Forewings, narrow; apex, acute; termen extremely oblique, grey-whitish; a few fuscous scales at apex; cilia, whitish. Hindwings with apex acute; termen strongly sinuate, whitish; cilia, whitish.

Strahan, in January; two specimens.

Gen. Idiozancla, nov.

ἰδιοξαγκλος, with peculiar sickles.

Tongue present. Palpi, with second joint extremely long, very much thickened with smoothly oppressed scales, a loose posterior tuft of long scales at apex, terminal joint short, slender, acute. Forewings with

2 and 3 stalked, 7 and 8 stalked, 7 to costal, 11 from well before middle. Hindwings about 1; apex round-pointed; termen not sinuate; 3 and 4 connate, 5 strongly curved and approximated to 4 at origin, 6 and 7 parallel.

A derivative of *Protolechia*, with peculiar palpi. Its relationship to *Ephelictis* is probably only collateral.

Idiozancla ignobilis, n sp.

ignobilis, obscure.

♀. 16 mm. Head, grey-whitish. Palpi, with second joint more than three times length of face, greatly thickened, smooth, but with a strong posterior tuft of scales at apex; terminal joint very short (⅕), very slender, acute, brown sprinkled with fuscous. Antennae, grey. Thorax, pale brownish-fuscous. Abdomen, grey-whitish. Legs, fuscous-brown; posterior pair, grey-whitish. Forewings, narrow; costa strongly arched; apex rounded; termen very oblique, pale brownish-fuscous; a fuscous plical dot at ⅓; cilia, grey. Hindwings, grey; cilia, whitish-grey.

Deloraine, in February; one specimen.

Protolechia platyzancla, n. sp.

πλτυζαγκλος, with broad sickles.

♂♀. 14-15 mm. Head, pale grey. Palpi with second joint reaching base of antennae; terminal joint ⅔, stout, fuscous; inner surface of second joint, whitish. Antennae, grey. Thorax, grey, with a posterior whitish spot. Abdomen, whitish-grey; posterior half in male whitish-ochreous. Legs, grey; posterior pair, whitish. Forewings, narrow; costa, slightly arched; apex, rounded; termen, very oblique; 2 and 3 stalked; pale fuscous; a broad white costal streak from base not quite reaching apex, sprinkled with a few fuscous scales, inferior edge straight, not indented stigmata obscurely darker, minute; first discal at ⅓, plical beyond it, second discal at ⅔; cilia, fuscous. Hindwings, with termen sinuate, grey; cilia, grey.

Allied to *P. invalida* Meyr. and *P. euryarga* Turn., but differing in many details, and especially in the stout wholly fuscous terminal joints of palpi.

St. Marys, in January (female type). Also a male from Caloundra, Queensland.

Family XYLORYCTIDAE

Xylorycta polysticha, n. sp.

πολυστιχος, many-striped.

♀. 26 mm. Head and thorax, pale fuscous. (Palpi missing.) Antennae, grey. Abdomen, grey-whitish; bases of segments ferruginous-fuscous. Legs, fuscous; posterior pair, whitish. Forewings sub-oblong; costa, gently arched; apex rounded; termen somewhat obliquely rounded, pale ochreous, irrorated, and streaked with pale fuscous; markings, shining white; a moderate costal streak from base to ⅖; three short, slender oblique streaks running to costa between this and apex; a broad median streak from base to end of cell at ⅔, dilated in middle to contain an elongate dark spot, and ending on a fuscous discal dot, from which two fine parallel streaks run to termen, beneath these three similar streaks, a fine streak on fold and another broader on dorsum extended on termen to near apex; cilia, fuscous; apices, white. Hindwings, 1½, pale grey; cilia, whitish.

Nearest, *X. calligramma* Meyr.

Derwent Bridge, in January; one specimen.

Xylorycta sucina, n. sp.

sucinus, amber-coloured.

♀. 34 mm. Head, grey. Palpi with second joint exceeding base of antennae, terminal joint ⅓, fuscous, base and extreme apex of second joint and whole inner surface, white. Antennae, grey, paler towards base. Thorax, ochreous-brown. Abdomen, grey; apices of segments and tuft, ochreous-whitish. Legs, whitish-ochreous. Forewings, elongate, slightly dilated; costa, gently arched; apex, rounded-rectangular; termen, straight, slightly oblique, brownish-ochreous; a white costal streak from base to apex; cilia, pale grey. Hindwings, nearly 2, grey; cilia, grey-whitish.

Derwent Bridge, in January; one specimen (G. and C. Davis).

Xylorycta melanochrysa, n. sp.

μελανοχρυσος, black and gold.

♂. 24 mm. Head, black; face, whitish-ochreous. Palpi with second joint reaching base of antennae; terminal joint ¼, whitish-ochreous; terminal joint, blackish. Antennae, blackish; ciliations in male minute. Thorax, orange-yellow; patagia and a posterior spot, black. Abdomen, black; tuft and apices of joints beneath, yellow. Legs, black; anterior coxae, flexor surfaces, tarsal rings, and most of posterior pair yellow. Forewings, sub-oblong; costa, slightly arched; apex, rounded; termen, moderately oblique; orange-yellow with three broad black transverse fasciae; first sub-basal, its posterior edge straight; second median, anterior edge from ⅓ costa to before mid-dorsum, slightly concave, posterior from beyond midcosta to ⅔ dorsum, angled outwards in middle of disc third terminal, its edge from ¾ costa to tornus, strongly convex; cilia, yellow; bases black, above tornus wholly black, before tornus wholly orange-yellow. Hindwings, 1; termen, sinuate, blackish; cilia, yellow; bases, blackish.

Hobart, in January; one specimen received from Capt. D. C. Pearse.

Lichenaula onychotypa, n. sp.

ὀνυχοτυπος, claw-marked.

♂. 20 mm. Head, white. Palpi with second joint not reaching base of antennae, terminal joint ⅔, white. Antennae, grey, towards base white; ciliations in male (1). Thorax, white; apices of tegulae and a posterior spot, fuscous. Legs, white; anterior pair, fuscous; middle tibiae and tarsi with fuscous rings. Forewings, sub-oblong; costa, moderately arched; apex, rounded; termen obliquely rounded; white heavily sprinkled with fusocus; markings, fuscous; an oblique, slightly curved line from beneath costa near base to near base of dorsum; a small dorsal suffusion, from middle of which a stout inwardly oblique line runs halfway across disc; an ill-defined fascia from midcosta to tornus; an erect line from tornus joining an elongate subapical costal spot, the posterior edge of which is again connected with tornus; a broad submarginal line from apex not reaching tornus; cilia, white with two interrupted fuscous lines. Hind wings, 1¼, whitish; extreme apex slightly suffused with grey; cilia. whitish, on apex, grey.

Hobart, in January; one specimen.

Procometis trispora, n. sp.

τρισπορος, three-spotted.

♀. 22mm. Head and thorax, fuscous-grey; face, grey-whitish. Palpi, smooth, slender, second joint reaching base of antennae; terminal joint ⅓, grey. Antennae, fuscous. Abdomen, grey; tuft, pale brownish. Legs, grey; posterior pair grey-whitish. Forewings, narrow; costa, moderately arched; apex, pointed; termen, extremely oblique; 7 to apex, grey with slight whitish irroration; markings, dark fuscous; a sub-basal dot just above fold; a large transverse spot at ⅓, apparently a fusion of a discal and a plical spot; a smaller spot in disc at ⅔; cilia, grey. Hindwings, 1½, grey; cilia, grey.

Hobart, in March; one specimen received from Capt. D. C. Pearse.

Family OECOPHORIDAE

The following species from Tasmania have been recently described.

Borkhausenia **nigripuncta* Turn. P.L.S.N.S.W., 1933, p. 93.

Macronemata Meyr. P.L.S.N.S.W., 1883, p. 345, **aphaurophanes* Turn., P.L.S.N.S.W., 1936, p. 305. Mt. Wellington (2500 feet).

Macronemata **omospila* Turn. P.L.S.N.S.W., 1936, p. 308. Mt. Wellington (2500 feet), Derwent Bridge, Gordon River.

Eccrita Turn. P.L.S.N.S.W., 1936, p. 317, **phaeoxysta* Turn., P.L.S.N.S.W., 1936, p. 317. Strahan.

Eulechria **phaeochorda* Turn. P.L.S.N.S.W., 1937, p. 96. Bothwell.

Eulechria **notera* Turn. P.L.S.N.S.W., 1938, p. 33. Mt. Wellington (2500 feet).

Eulechria **metaleuca* Turn. P.L.S.N.S.W., 1938, p. 33. Mt. Wellington (2500 feet).

Eulechria **ochrophara* Turn. P.L.S.N.S.W., 1938, p. 33. Strahan.

Eulechria **botryospila* Turn. P.L.S.N.S.W., 1936, p. 47. Deloraine.

(*See footnote to p. 66.)

Leptocroca stictocrossa, n. sp.

στικτοκροσσος, with dotted border.

♀. 20-22 mm. Head and thorax, grey. Palpi with second joint not reaching base of antennae, terminal joint ⅔, grey. Antennae, grey; ciliations in male 1. Abdomen, grey; tuft, ochreous-whitish. Legs, grey; posterior pair, ochreous-whitish. Forewings, narrowly elongate-oval; costa, rather strongly arched; apex, pointed; termen, strongly oblique; 2 and 3 stalked; grey sprinkled with fuscous, which sometimes forms fine longitudinal lines; stigmata obscure, fuscous, usually minute, first discal at ⅓, plical before it, second discal before ⅔; a short, whitish transverse bar above tornus; a submarginal series of fuscous dots along termen and apical half of costa; cilia, grey-whitish, bases barred with fuscous. Hindwings, pale grey; cilia, whitish.

Allied to *L. eucentra.* Apart from differences in coloration, the antennal ciliations are much shorter.

Mt. Wellington, Derwent Bridge, and Mt. Barrow, in February; three specimens received from Mr. G. M. Goldfinch, who has the type.

Leptocroca diachorda, n. sp.

διαχορδος, strung right through.

♀. 22 mm. Head and thorax, white densely sprinkled with fuscous. Palpi with second joint much exceeding base of antennae; terminal joint scarcely more than ½, white; terminal joint and a subapical ring on second joint dark fuscous. Antennae, fuscous narrowly ringed with white. Abdomen with basal segments grey on dorsum; terminal, ochreous; tuft, sides, and lower surface, whitish. Legs, fuscous with whitish rings; posterior pair whitish. Forewings, suboval, rather narrow; costa, gently arched; apex, rounded; termen, very obliquely rounded, white unevenly sprinkled with fuscous; markings, dark fuscous; a small spot on base of costa; a strongly marked subcostal streak from base, somewhat irregular and two or three times interrupted, near apex sharply angled into a fine subterminal line to tornus; a series of elongate dots on apical ⅓ of costa prolonged along termen, but becoming confluent and less conspicuous towards tornus; cilia, pale grey, barred on costal spots; apices, white. Hindwings and cilia, pale grey.

Very like *L. sphaleropis* Meyr., but with a much longer streak on forewings and shorter terminal joint of palpi. In that species the terminal joint is ¾, the antennae are grey, and the dorsum of the abdomen grey with white edges to the segments.

Barea tanaodes, n. sp.

ταναώδης, long.

♂. 23-26 mm. Head, brown-whitish. Palpi with second joint exceeding base of antennae; terminal joint ⅔, fuscous; apex of second joint, whitish. Antennae, whitish annulated with pale fuscous; ciliations in male 1. Thorax, brown-whitish anteriorly sprinkled with fuscous; a posterior fuscous spot. Abdomen, pale ochreous-grey. Legs, fuscous with ochreous whitish rings; posterior pair mostly ochreous-whitish. Forewings, elongate, somewhat dilated posteriorly; costa, moderately arched; apex, rounded; termen obliquely rounded; 2 and 3 stalked; brown-whitish densely irrorated with fuscous; markings, dark fuscous; a whitish basal spot; an irregular suffused basal patch variable in extent; first discal at ⅓, plical slightly before it, second discal before ⅔; an interrupted line or series of dots from costa at ¾ running close to margin around apex and termen to tornus, between it and termen a series of pale spots; cilia, grey sprinkled with fuscous; apices, ochreous-whitish. Hindwings broader than forewings; grey-whitish; cilia whitish.

This appears to be near *B. fenicoma* Meyr., from Mt. Kosciusko. One of my examples has 2 and 3 of forewings coincident on both sides, the other being normal. It is necessary to regard this as an individual aberration. I have an example of *Philobota orphnites* Turn., in which a similar abnormality occurs, and unfortunately led me to describe it as the type of a new genus *Atribasta*.

Waratah, in January and February; two specimens; Mt. Wellington, in February (Goldfinch).

Locheutis delopasta, n. sp.

δηλοπαστος heavily sprinkled.

♂. 16 mm. Head and thorax, fuscous. Palpi with second joint exceeding base of antennae; terminal joint ⅔, fuscous; extreme apex of second joint, whitish. Antennae, fuscous; in male with tufts of long cilia (2½). Abdomen, ochreous-grey. Legs, fuscous with whitish rings (posterior pair missing). Forewings, narrow; costa, gently arched; apex, rounded; termen, very oblique, brownish-grey; markings and irroration dark fuscous; a dot on base of costa, closely followed by another beneath costa; a dot on base of dorsum; first discal at ⅓, plical much before it, second discal about middle; a suffused costal spot beyond middle and another towards apex; cilia, grey. Hindwings and cilia, grey.

Waratah, in January; one specimen.

Elaeonoma typhodes, n. sp.

τυφωδης, smokey.

♂. 23 mm. Head and thorax, whitish. Palpi with second joint much exceeding base of antennae; terminal joint ⅔, fuscous; inner surface and apex of second joint whitish. Antennae, ochreous-whitish; ciliations in male 1. Abdomen, ochreous-grey-whitish. Legs, fuscous with ochreous-whitish rings; posterior pair, whitish. Forewings, elongate, somewhat dilated; costa, slightly arched; apex, rounded; termen, obliquely rounded, ochreous-whitish sprinkled with fuscous, more densely on basal half of dorsal area; a fuscous discal dot at ⅔; cilia, ochreous-whitish. Hindwings and cilia, whitish.

The type is in rather poor condition.

Mt. Wellington (2500 feet), in February; one specimen.

Mermeristis thioptera, n. sp.

θειοπτερος, sulphur-winged.

♂. 10-12 mm. Head and thorax, pale yellow. Palpi with second joint scarcely reaching base of antennae; terminal joint ½, pale yellow. Antennae, fuscous; ciliations in male 5. Abdomen, fuscous; tuft, ochreous-whitish. Legs, fuscous. Forewings, narrow, dilated posteriorly; costa, gently arched; termen, oblique, pale yellow; costal edge near base, blackish; stigmata, blackish, first discal at ⅓, plical before it, second discal before ⅔; a round patch of fuscous suffusion between second discal and tornus; cilia, grey; bases, blackish; on apex and costa, pale yellow. Hindwings, narrowly elongate-ovate. fuscous; cilia, fuscous.

Mt. Wellington, Russell Falls, Zeehan, and Cradle Mountain (3000 feet), in February; five specimens. Type in Coll. Goldfinch.

Macronemata dielipha, n. sp.

διηλιφος, well anointed.

♂. 12 mm. Head, whitish-ochreous. Palpi with second joint not reaching base of antennae; terminal joint $\frac{1}{3}$, whitish-ochreous: external surface, except apex of second joint, fuscous. Antennae, fuscous; ciliations in male 1. Thorax, dark fuscous. Abdomen, dark fuscous; tuft, ochreous-whitish. Legs, fuscous; posterior pair, grey-whitish. Forewings, narrow; costa, moderately arched; apex, pointed; termen, very oblique, glossy ochreous-whitish; markings, dark fuscous; a narrow basal fascia shortly produced on costa; a subtriangular costal spot beyond middle and another at apex; a discal dot at $\frac{2}{3}$; cilia, fuscous, below midtermen, whitish. Hindwings and cilia, grey.

Mt. Wellington (1500 feet), in January; one specimen.

Macronemata pauxilla, n. sp.

pauxillus, small.

♂. 11 mm. Head, thorax, and abdomen fuscous. Palpi with second joint not reaching base of antennae; terminal joint $\frac{2}{5}$, fuscous. Antennae, fuscous; ciliations in male 4. Legs, fuscous. Forewings, narrow, suboval; costa, gently arched; apex, rounded; termen, very oblique, grey, lightly sprinkled with fuscous; discals, fuscous, approximated, first at $\frac{2}{5}$, second at $\frac{3}{5}$, plical obsolete; cilia, grey with fuscous points. Hindwings and cilia, grey.

Scottsdale, in January; one specimen.

Macronemata lioptera, n. sp.

λειοπτερος, smooth-winged.

♀. 18 mm. Head, thorax, abdomen, and legs, pale grey. Palpi, slender, second joint reaching base of antennae; terminal joint $\frac{2}{5}$, pale grey. Forewings, very narrow; costa, straight to near apex, there arched, apex acute; termen very oblique, grey; a quadrangular costal area from near base to $\frac{3}{4}$ and reaching middle of disc, white; discals, fuscous, at $\frac{3}{8}$ and $\frac{3}{4}$ on edge of whitish area, plical obsolete; cilia, whitish. Hindwings, pale grey; cilia, whitish.

Derby, in January; one specimen.

Macronemata leucocrana, n. sp.

λευκοκρανος, with white head.

♀. 17 mm. Head, whitish. Palpi with second joint exceeding base of antennae; terminal joint ⅔, fuscous; base and extreme apex of second joint and whole internal surface, whitish. Antennae, fuscous. Thorax, grey; patagia, whitish. Abdomen, grey; tuft, whitish. Legs, fuscous (posterior pair missing). Forewings, narrow, somewhate dilated posteriorly; costa, very slightly arched; apex, pointed; termen, very oblique; whitish, unevenly sprinkled with fuscouse; this irroration is very scanty in costal and central areas, more abundant in basal ¾ of dorsal area, and forms ill-defined spots on costa before apex and on tornus, and an ill-defined terminal line; stigmata, fuscous, first discal at ⅓, plical beyond it, second discal at ⅔, connected with tornal suffusion, a dot above and between discals; cilia, whitish. Hindwings, broadly lanceolate, grey-whitish; cilia, whitish.

An obscure species, but characterized by the whitish head, whitish ground-colour of forewings, almost whitish hindwings, and long palpi.

Waratah, in December; one specimen.

Eulechria goniosticha, n. sp.

γωνιοστιχος, with angled line.

♂ ♀. 20 mm. Head and thorax, brownish-grey. Palpi with second joint much exceeding base of antennae, 2½ times length of face; terminal joint ¾, fuscous; inner surface and apex of second joint, grey. Antennae ochreous-grey; ciliations in male 1½. Abdomen, ochreous-grey-whitish. Legs, fuscous; posterior pair, ochreous-whitish. Forewings, narrow, slightly dilated; costa moderately arched; apex, round-pointed; termen oblique, whitish-ochreous; markings and some scattered scales blackish, sometimes a basal costal dot; first discal at ¼, plical beyond, second discal at middle; an interrupted inwardly-oblique line from ⅔ costa, sharply indented above middle, thence curved to tornus; in the female example this line is scarcely traceable; cilia, whitish-ochreous. Hindwings and cilia, pale grey.

Weldborough, in January; two specimens.

Eulechria albifrons, n. sp.

albifrons, white-faced.

♂. 20 mm. Head and thorax, pale grey; face, white. Palpi with second joint reaching base of antennae; terminal joint ⅔, pale grey; terminal joint and apex of second joint, white. Antennae, pale grey; ciliations in male 1½. (Abdomen missing). Legs, fuscous (posterior pair missing). Forewings, elongate, narrow; costa, gently arched; apex, pointed; termen, very oblique; pale grey; a white costal streak from base to beyond middle; cilia, pale grey. Hindwings and cilia, whitish.

Waratah, in February; one specimen.

Eulechria irenitis, n. sp.

εἰρηνιτις, peaceful.

♂♀. 20-22 mm. Head, white. Palpi with second joint reaching base of antennae; terminal joint ¼, fuscous or grey; terminal joint and apex of second joint white. Antennae, ochreous-grey; ciliations in male 5. Thorax, pale ochreous-grey. Abdomen, grey; apices of segments and tuft, whitish. Legs, grey; posterior pair, ochreous-whitish. Forewings, elongate, somewhat dilated; costa, slightly arched; apex, rectangular; termen, moderately oblique, whitish-grey sparsely sprinkled with pale ochreous; a suffused whitish costal streak before middle; some fuscous scales on costa beyond middle and on apex and termen; cilia, whitish, on apex, fuscous. Hindwings and cilia, whitish.

Not unlike the preceding, but the antennal ciliations are much longer.

Cradle Mountain (3000 feet), in January; two specimens received from Mr. W. B. Barnard.

Eulechria spreta, n. sp.

spretus, despised.

♂. 20 mm. Head and thorax, fuscous. Palpi with second joint reaching base of antennae; terminal joint ⅓, grey; outer surface of second joint fuscous. Antennae, grey, ciliations in male 1¼. Abdomen, grey; dorsum of terminal segments partly brownish. Legs, fuscous; posterior pair grey-whitish. Forewings, somewhat dilated; costa, gently arched; apex, obtusely pointed; termen, oblique; light fuscous with some dark fuscous sprinkling; markings, dark fuscous; stigmata, dot-like, first discal at ⅓, plical beyond it, second discal before ⅔; a line of minute dots from ¾ costa obliquely outwards angled rectangular before apex, thence curved parallel to tornus; cilia, light fuscous. Hindwings and cilia, pale grey.

This may be placed before *E. lissopolia* Turn.

St. Marys, in January; one specimen.

Machimia phaeoporphyra, n. sp.

φαιοπορφυρος, dusky purple.

♂. 22 mm. Head and thorax, purple-grey. Palpi with second joint exceeding base of antennae; terminal joint ⅔, grey. Antennae, fuscous; ciliations in male 1. Abdomen, grey; apices of segments and tuft, grey-whitish. Legs, grey-whitish; anterior pair, fuscous Forewings, broad, posteriorly dilated; costa, strongly arched; apex, rounded-rectangular; termen, slightly rounded; slightly oblique, grey-whitish very densely irrorated with purple-grey; stigmata, minute, almost imperceptible, first discal at ⅓, plical beyond it, second discal before ⅔; cilia, grey-whitish with darker points. Hindwings, broadly ovate; pale grey; cilia, pale grey.

Dark in colour for this genus, but agreeing structurally.

Derwent Bridge, in January; one specimen.

Machimia rubella, n. sp.

rubellus, pink.

♂. 30-32 mm. Head and thorax, pale ochreous-pink. Palpi with second joint exceeding base of antennae; terminal joint ⅜ to ¾, pale pinkish, towards base ochreous-whitish. Antennae, grey towards base ochreous-tinged; ciliations in male ½. Abdomen, grey; apices of segments ochreous-whitish; tuft, whitish-ochreous. Legs, ochreous-whitish; anterior pair, pinkish-fuscous. Forewings, moderately broad; costa, strongly arched; apex, rounded-rectangular; termen, slightly rounded, slightly oblique, pale pink (slightly inclined to be rosy-purple), in one example greyish-pink; costa, narrowly pink, extreme edge whitish; markings, inconspicuous, fuscous, or partly reddish; first discal at ⅓, plical beyond it, second discal before ⅔; a line of minute dots from midcosta obliquely outwards, sharply angled midway between second discal and apex, thence curved inwards to tornus; a terminal series of dots; cilia, pink; apices, whitish. Hindwings, ochreous-whitish slightly suffused with grey, except near base; cilia, ochreous-whitish.

The forewings of *M. brachytricha* are ochreous-pink, inclining to pale brick-red.

Derwent Bridge in January; seven specimens all ♂, one ♀ 27 mm. Triabunna.

Machaeretis compsa, n. sp.

κομψος, neat.

♂. 10-13 mm. Head, grey-whitish or ochreous-whitish. Palpi with terminal joint ⅗, fuscous, inner surface, whitish. Antennae, grey annulated with fuscous; ciliations in male 3. Thorax, pale grey. Abdomen, grey. Legs, fuscous; posterior pair, grey. Forewings, narrow; costa, gently arched; apex, round-pointed; termen, oblique, ochreous-whitish; markings and some irroration fuscous; a sharply defined somewhat elongate basal costal spot; first discal at 3/8, plical well before it, but the former is usually, and the latter often, not developed, second discal at 2/3; in one example a costal spot at 3/5; an interrupted subterminal line, sharply indented beneath costa, thence obliquely curved to 2/3 dorsum, usually partly or wholly obsolete; cilia, ochreous-whitish. Hindwings and cilia, grey.

I formerly confused this with *M. psathyra* Meyr., of which I had not then seen an example. It may be distinguished by the sharply defined basal costal spot and the much larger antennal ciliation (in *psathyra* at most 1½).

Cradle Mountain (3000 feet), Russell Falls, and Lake Fenton (3500 feet), in January; eight specimens.

Haplodyta ochrogramma, n. sp.

ὠχρογραμμος, with pale marking.

♂. 18-19 mm. Head and thorax, fuscous. Palpi with second joint exceeding base of antennae; terminal joint 3/5, fuscous. Antennae, fuscous; ciliations in male 2. Abdomen, grey; bases of segments ferruginous-fuscous on dorsum. Legs, fuscous; posterior pair, pale grey. Forewings, narrow; costa, slightly arched; apex, acute; termen, straight, oblique, slightly sinuate beneath apex, fuscous; a broad grey-whitish streak from base narrowing to mid-dorsum, edged above by blackish suffusion; a whitish dot in disc below middle at 3/5; stigmata obscure or undeveloped, first discal at 1/3, second touching upper side of whitish dot; cilia, fuscous. Hindwings and cilia, grey.

Weldborough and Derby, in January; two specimens.

Coesyra cerochyta, n. sp.

κηροχυτος, waxen.

♂. 20 mm. Head and thorax, ochreous-whitish. Palpi, with terminal joint 2/3, ochreous-whitish. Antennae, pale grey; ciliations in male 2. Abdomen, grey. Legs, fuscous; posterior pair, grey. Forewings with costa moderately arched; apex, rounded; termen, obliquely rounded; glossy ochreous-whitish; costal edge blackish near base; stigmata, dotlike but distinct, blackish, first discal at 1/3, plical well beyond it, second discal at 2/3, cilia, ochreous-whitish. Hindwings and cilia, grey.

Easily distinguished from *C. ochrocirrha* Turn., which it resembles, by the plical dot being beyond first discal.

Mt. Wellington (2500 feet), in January; one specimen.

Pyrgoptila dasciopa, n. sp.

δασκιωπος, dark.

♀. 24 mm. (Head badly rubbed.) Antennae, fuscous. Palpi with second joint more than three times length of face, terminal joint ⅓, fuscous, second joint with apex and inner surface whitish. Thorax, fuscous; posterior part of crest whitish. Abdomen, grey. Legs, fuscous, more or less suffused with whitish. Forewings, elongate, slightly dilated; costa moderately arched; apex, round-pointed; termen very oblique, fuscous lightly sprinkled with whitish and with some dark fuscous suffusion; a whitish basal dot; an elongate whitish spot on dorsum near base; stigmata, dark fuscous edged posteriorly with whitish, first discal at ⅓, plical beyond it, second discal slightly beyond middle; a subdorsal ridge of dark fuscous scales from base to ⅓, terminating in a tuft, which is edged posteriorly by a short, oblique ochreous-whitish streak; beyond this is a smaller crest of dark fuscous scales; some whitish suffusion on costa before apex, on dorsum before tornus, and before termen; cilia, grey-whitish sprinkled with fuscous. Hindwings and cilia, whitish-grey.

Scottsdale, in January; one specimen.

Pyrgoptila mochlonota, n. sp.

μοχλονωτος, with bar on dorsum.

♂. 20-22 mm. ♀ 18 mm. Head and thorax, fuscous. Palpi, with second joint exceeding base of antennae; terminal joint, ½ in male, ⅔ in female; whitish, more or less sprinkled with fuscous; terminal joint, mostly fuscous, but apex whitish. Antennae, fuscous; ciliation in male, 2. Abdomen, grey; bases of segments, ferruginous in male; tuft, grey-whitish. Legs, fuscous, with whitish tarsal rings; posterior pair, mostly whitish. Forewings rather narrow, strongly dilated; costa, gently arched; apex, pointed; termen, oblique, fuscous-grey; a broad grey-whitish dorsal bar, with a small median projection, from mid-base to tornus, separated from dorsum near base, edged above by dark fuscous suffusion; stigmata, dark fuscous, first discal at ¼, sometimes edged posteriorly with white; plical, lost in suffusion, second discal, at ⅔, with a white spot beneath it; in female a dot above and between discals; cilia, grey, sprinkled with dark fuscous—on tornus, grey-whitish. Hindwings and cilia, pale grey.

Triabunna (2 ♀), Derwent Bridge (♂), and Waratah (♂ type), in February; four specimens received from Mr. G. M. Goldfinch who has the type.

Philobota chrysosticha, n. sp.

χρυσοστιχος, gold-streaked.

♂. 22-26 mm. ♀. 20-22 mm. Head, orange-yellow; face fuscous. Palpi, with second joint exceeding base of antennae; terminal joint, ⅔; fuscous, posterior surface, whitish. Antennae, fuscous; ciliations in male, 2½. Thorax, fuscous. Abdomen, grey, darker towards base; apices of segments, whitish. Legs, fuscous,; posterior pair, grey or grey-whitish. Forewings, dilated posteriorly in male; narrower in female; costa, gently arched; apex, round-pointed; termen, obliquely rounded; slaty-grey; a white costal streak from base to ⅔; a series of orange-yellow (rarely pale yellow) streaks; a narrow streak beneath costa to ⅔; a median streak from ⅓ to termen beneath apex, giving off a branch to apical part of costa and a short branch to midtermen; a streak along fold from base to tornus; a dorsal streak to beyond middle, sometimes imperfectly developed; cilia, grey. Hindwings and cilia, pale grey.

This should not be confused with the allied *P. aurceps* Butl. In that species the colour of forewings is bright yellow, with variably developed dark fuscous streaks and small apical blotch.

Hobart, Derwent Bridge (2000ft.), and Cradle Mountain (3000 feet), in January. Victoria: Mt. Buffalo (4000 feet) and Mt. Erica (5000 feet), in January and February. New South Wales: Mt. Kosciusko (5500 feet), in January; Tweed Heads (Coolangatta), in September. This is a mountain species. Its occurrence at Hobart may be attributed to the vicinity of Mt. Wellington, and the solitary example from Coolangatta is probably a straggler from the Macpherson Range. The type is from Cradle Mountain.

Philobota metarga, n. sp.

μεταργος, white posteriorly.

♂♀. 20 mm. Head and thorax, grey-whitish. Palpi, with second joint exceeding base of antennae; terminal joint, ⅔; whitish, external surface of second joint, except apex, fuscous. Antennae, grey; ciliations in male, 2. Abdomen, ochreous-grey; apices of segments and tuft, whitish-grey. Legs, fuscous, with whitish rings; posterior pair, whitish. Forewings, narrow, slightly dilated; costa, slightly arched; apex, pointed; termen obliquely rounded; grey-whitish; markings and some irroration, dark fuscous; basal dots on costa and dorsum; first discal, at ⅓; plical, beneath or slightly beyond; second discal, before ⅔; an interrupted line or series of dots from ¾ costa obliquely outwards, angled beneath costa and continued parallel to termen to tornus; cilia, grey-whitish. Hindwings and cilia, white.

Hobart and Mt. Wellington (2500 feet), in February; four specimens.

Philobota fulvella, n. sp.

fulvus, brownish-yellow.

♂♀. 16-18 mm. Head and thorax, brownish-yellow;; face, whitish. Palpi, with second joint just reaching base of antennae; terminal joint, ½; brownish-yellow. Antennae, grey; ciliations in male, 1½. Abdomen, grey; tuft, whitish-ochreous. Legs, grey; posterior pair, whitish. Forewings, rather broad, dilated posteriorly; costa gently arched; apex, obtusely pointed; termen moderately oblique; brownish-yellow; costal edge, fuscous towards base; terminal edge, sometimes grey; cilia, whitish; bases, grey. Hindwings and cilia, grey.

Broader-winged than its allies *P.* tyroxantha Meyr., in which second joint of palpi exceeds base of antennae, *P. melichrodes* Turn., which has a whitish head, and *P. mlirrhoa* Meyr., which has the thorax anteriorly fuscous.

Strahan, in January; three specimens.

Philobota crypsirrhoda, n. sp.

κρυψιρρoδος, with hidden rose-colour.

♂. 19-20 mm. Head, pale yellow; sides of face, reddish. Palpi, with second joint reaching base of antennae; terminal joint, ½, slender; pale yellow; outer surface of second joint, rosy-suffused. Antennae, grey; basal joint, reddish; pecten, rosy; ciliations in male, 1. Thorax, reddish (partly descaled). Abdomen, whitish; dorsum of anterior segments, grey-brown; tuft, dark fuscous. Legs, pale yellowish. Anterior pair, fuscous, reddish-tinged; posterior pair, with spurs and proximal tarsal joints, fuscous Forewings, subtriangular; costa gently arched; apex, obtusely pointed; termen, very obliquely rounded; yellow; a purple-fuscous costal streak from base to ⅔, edged beneath with reddish; a broad, oblique, purple-fuscous line, edged with reddish from costa near apex to midtermen; cilia, yellow—on apex reddish. Hindwings, whitish, tinged, rosy posteriorly; cilia, yellow. Underside of forewings, almost wholly bright rosy.

An isolated species not near any other.

Hobart, in February; two specimens received from Capt. D. C. Pearse.

Philobota dolichothrix, n. sp.

δολιχoθριξ, long-haired.

♂. 16 mm. Head, white. Palpi, with second joint reaching base of antennae; terminal joint, ⅔; whitish. Antennae, grey; ciliations in male, 6. Thorax and abodmen, pale grey. Legs, grey; posterior pair, whitish. Forewings, narrow, suboval; costa, moderately arched; apex, pointed; termen, very oblique; white; markings, pale grey; stigmata, large suffused spots, first discal at ⅔, plical beneath and more or less confluent with it, second discal at ⅔; a suffused spot on tornus and a sprinkling of pale grey scales in terminal part of disc; cilia, white. Hindwings and cilia, whitish-grey.

Remarkable for the extremely long antennal ciliations of the male.

Tasman Peninsula and Strahan, in January; two specimens.

Philobota casta, n. sp.

castus, spotless.

♀♂. 17-18 mm. Head and thorax, grey-whitish. Palpi, with second joint just reaching base of antennae; terminal joint, ¾; grey-whitish. Antennae, grey-whitish; ciliations, in male, 3. Abdomen, grey. Legs, pale grey; posterior pair, whitish. Forewings, elongate, narrow; costa, gently arched; apex, pointed; termen, very oblique; grey-whitish; cilia, grey-whitish. Hindwings and cilia, whitish.

Mt. Wellington (2500 feet), in January and February; three specimens.

Leistomorpha trissosema, n. sp.

τρισσοσημος, three-marked.

♂. 15-17 mm. Head, thorax, and abdomen, dark fuscous. Palpi, with second joint reaching base of antennae; terminal joint, ¾; dark fuscous. Antennae, dark fuscous; ciliations in male, 2½. Legs, dark fuscous, with ochreous-whitish rings; mid and posterior tibiae, with median and terminal whorls of short, ochreous-whitish hairs. Forewings, rather narrow; costa, gently arched; apex, obtusely pointed; termen straight, oblique; dark fuscous; a short, outwardly oblique, ochreous-whitish mark from dorsum beyond middle; similar, but shorter, marks on costa at ⅓ and ⅔, but these may be weakly developed or obsolete; a few ochreous-whitish scales in terminal area; cilia, dark fuscous; apices, ochreous-whitish. Hindwings and cilia, dark grey.

This genus has the pecten absent or represented by one or scales only. The present species is peculiar in its tibial structure, but appears nearly allied to *L. brontoscopa*.

Derwent Bridge, in February; three specimens received from Mr. G. M. Goldfinch, who has the type.

Chrysonoma platyzostra, n. sp.

πλατυζωστρος, broadly banded.

♀. 22 mm. Head and thorax, whitish. Palpi, with second joint exceeding base of antennae; terminal joint slender, nearly as long as second (⅚); fuscous. Antennae, fuscous. Abdomen, grey; apices of segments and tuft, whitish-ochreous. Legs. fuscous; posterior tibiae, whitish-ochreous. Forewings, with costa moderately arched; apex, round-pointed; termen, straight, moderately oblique; ochreous-whitish; costal edge at base, blackish; markings, fuscous; a broad, antemedian fascia; anterior edge from ⅓ costa to ¼ dorsum; posterior, from midcosta to mid-dorsum, both somewhat wavy; a fascia from ⅔ costa to tornus, narrow on costa, soon broadening in disc; a triangular terminal blotch, from apex nearly to tornus; cilia, whitish-ochreous on apex, broadly fuscous. Hindwings, grey; cilia, whitish.

Tasman Peninsula, in January; one specimen.

Fam. HYPONOMEUTIDAE

Zelleria malacodes, n. sp.

μαγακωδης, soft.

♀. 14 mm. Head and thorax, grey-whitish. Palpi, whitish. Antennae, grey-whitish. Abdomen, pale grey; tuft, whitish. Forewings, narrow; costa, strongly arched; apex, acute, produced; grey-whitish; a few blackish points near costa, above tornus, and at apex; cilia, whitish; on apex grey. Hindwings, lanceolate; cilia, 1; whitish; cilia, whitish.

Cradle Mountain (3000 feet), in February; one specimen.

Gen. **Amblyzancla**, nov.

ἀμβλυξαγκλος, with obtuse sickles.

Tongue, present. Palpi, moderately long, curved, ascending, not reaching vertex, smooth-scaled; second joint, long slightly expanded at apex; terminal joint, short, obtuse. Antennae, ¾; in male, shortly ciliated. Forewings, with 7 and 8 stalked, 7 to apex. Hindwings, with 3 absent, 5, 6, 7 approximately at origin.

Amblyzancla araeoptila, n. sp.

ἀραιοπτιλος, narrow-winged.

♂. 15 mm. Head, palpi, and thorax whitish-grey. Antennae, grey; ciliations in male ¼. Abdomen, grey. Legs, grey (posterior pair missing). Forewings, narrow; costa, slightly arched; apex, acute; grey, sprinkled with whitish, minute, blackish discal dots at middle and ¾, the former connected by an inwardly oblique line with dorsum before middle; a blackish apical spot; cilia, grey, on apex, blackish. Hindwings, narrow-lanceolate; cilia, 3; grey; cilia, grey.

St. Marys, in January; one specimen.

Gen. **Anoista,** nov.

ἀνωιστος, unlooked for, unforeseen.

Head, smooth-scaled; sidetufts, moderate. Tongue, present. Maxillary palpi, obsolete. Labial palpi, ascending, recurved, moderately stout, smooth-scaled; second joint not reaching base of antennae; terminal joint, ⅓, rather stout, obtusely pointed. Antennae, without basal pecten. Thorax, smooth. Posterior tibiae, smooth-scaled; spurs, especially inner ones, long. Forewings, with all veins present and separate, 2, 3, 4, 5, 6, equidistant, 3 from angle, 7 to apex, well separated at origin from 8, 11 from middle. Hindwings, with 2 from near angle, 3 and 4 short-stalked, 5 approximated to 6 at origin, 6 and 7 well separate, parallel nearly to their middle, thence slightly diverging.

A somewhat anomalous and rather primitive genus. The type species is in general appearance an *Oecophorid*, but the separate 7 of forewings and the smooth posterior tibiae undoubtedly refer it to the *Hyponomeutidae*.

Anoista insolita, n. sp.

insolitus, unusual, strange.

♂. 18-20 mm. Head, grey-whitish. Palpi, fuscous; apex of terminal and inner surface of second joint, whitish. Antennae, grey; ciliations in male, 1½. Thorax, pale grey; bases of tegulae, fuscous. Abdomen, whitish-ochreous. Legs, fuscous with whitish rings; posterior tibiae, grey or whitish. Forewings, elongate-oval; costa, rather strongly arched; apex pointed, termen, oblique; grey; costa, with fuscous strigulae; a broad white dorsal area joined by an outwardly oblique fascia from costa near base; a broad dark fuscous line partly double on outer edge of fascia almost reaching fold; a reddish-ochreous median spot immediately follows this, and from it a narrow, ochreous, longitudinal suffusion proceeds to ⅔, and there expands fan-wise, not reaching margins; a white dot at about ⅔ edged with dark fuscous lies in the upper fork of a small dark fuscous X mark; terminal veins, with series of dark fuscous dots; a small, dark fuscous blotch above tornus; cilia grey, bases barred with dark fuscous. Hindwings, elongate-ovate; apex, obtusely rounded; termen, not sinuate; whitish-grey; cilia, grey-whitish.

Derwent Bridge, in February; two specimens received from Mr. G. M. Goldfinch, who has the type.

Fam. GRACILARIADAE

Lithocolletis acares, n. sp.

ἀκαρης, tiny.

♂. 5-6 mm. Head and thorax, grey. Labial palpi, whitish; second and terminal joints, with broad median fuscous rings. Antennae, fuscous; in male simple. Abdomen and legs, fuscous. Forewings, narrow; costa, usually slightly, but in one example strongly arched; apex, pointed; rather dark grey; markings, white; a fine streak on fold from near base to first transverse line; first line from ⅓ costa obliquely outwards to fold, there angled inwards to mid-dorsum; a short, but rather broad, oblique line from midcosta to middle of disc; second line transverse, slightly curved outwards from ⅔ costa to tornus; third line from ⅚ costa to termen above middle; a blackish apical dot; cilia, grey. Hindwings, linear-lanceolate; grey; cilia, 6, grey.

I have had difficulty in determining the genus of this minute species, and therefore give its structural characters. The head is loosely scaled, but not rough. The tongue is well developed. The labial palpi are long, porrect, mostly smooth, but with some long projecting scales on lower surface, and the maxillary palpi are minute, but distinct and porrect. All the tibiae are smooth-scaled. There can therefore be no doubt that it belongs to the *Gracilariadae*. I should have referred it to *Acrocercops*, if it had not been for the smooth posterior tibiae. It seems to agree fairly well with *Lithocolletis*, though the tibiae are exceptional and it has no near relationship to the two described Australian species.

Mt. Wellington (4000 feet), in January, locally abundant in a restricted area, covered with dwarf shrubs; eight specimens.

Phyllocnistis enchalcoa, n. sp.

ἐγχαλκος, brassy.

♂ ♀. 6-8 mm. Head and thorax, brassy. Palpi, white. Antennae, fuscous. Abdomen, fuscous. Legs, fuscous, with white rings. Forewings, rather narrow, dilated posteriorly; apex, obtuse; bright brassy-metallic; four narrow, shining, white transverse fasciae, each edged anteriorly by a fine blackish line, at ¼, middle, ¾, and subapical; a large blackish apical spot; cilia brassy, on apex and tornus, fuscous. Hindwings, linear-lanceolate; cilia, 5; grey; cilia, grey.

Hobart, in April. Dr. V. V. Hickman found these tiny moths in great numbers in his garden at New Town, and sent me specimens, which arrived dry, and were very difficult to deal with. Subsequently he sent others by air-mail. These arrived alive, but badly rubbed from having tried to escape through the cottonwool, with which the glass tube was plugged. However, they showed the structural characters better. After a search made at my suggestion, he found blotches on the leaves of a native shrub *Plagianthes sidoides.* These contained cocoons, which were by this time either empty or parasitised.

Dr. Hickman informs me that the food plant is one of the *Malvaceae,* and sends the following particulars: " The egg is white and coarsely sculptured on the chorion. It is oval in shape, and measures 0·30 mm. long by 0·17 wide. The moth attaches the eggs to the stellate hairs on the underside of the leaf. Some were found to be hatching in April. The newly-hatched larva measures 0·48 mm. long. As soon as its head protrudes from the chorion, it commences to bore its way into the leaf. The empty chorion remains attached to the leaf for some time before a yellow blotch discloses the situation of the mine. The first two instars are completely apodous. In two dead, and apparently mature, larvae the thoracic legs and three pairs of prolegs are present."

Fam. PLUTELLIDAE

Gen. **Leurophanes,** nov.

λευροφανης, smooth.

Tongue, well developed. Labial palpi, long, slender, smooth, curved, ascending; second joint reaching base of antennae; terminal joint, shorter and more slender than second, acute. Maxillary palpi, minute. Antennae without basal pecten; ciliations in male, minute. Posterior tibiae, smooth. Forewings, with 2 and 3 stalked, 7 and 8 stalked, 7 to termen, 11 from middle. Hindwings, with 2 and 3 connate, 5 from below middle, 6 and 7 stalked.

Leurophanes oresibates, n. sp.

ὀρεσιβατης, mountain-ranging.

♂. 20-22 mm. Head, whitish. Palpi, with terminal joint ⅔; whitish, external surface of second joint except apex, grey. Antennae and thorax, grey. Abdomen, pale grey; apices of segments and tuft whitish. Legs, fuscous; posterior pair pale grey. Forewings, elongate, costa moderately arched; apex, pointed; termen, straight, oblique; grey, brownish-tinged; a median whitish suffusion from base to ⅔; a fuscous streak beneath this from ⅓ to ⅔, enlarged at posterior end, a suffused fuscous spot between this and apex; cilia, whitish, sometimes grey on apex and tornus. Hindwings, 1½, elongate-ovate; grey-whitish; cilia, whitish.

Mt. Wellington (4000 feet), in January; four specimens.

Fam. LYONETIADAE

Dryadaula anthracodeta, n. sp.

ἀγθρακοδετος, black-rimmed.

♂ ♀. 12 mm. Head, palpi, antennae, and thorax, white. (Abdomen, missing.) Legs, fuscous, with white rings; posterior pair, mostly white. Forewings, narrow; costa straight to near apex; apex, conical; termen, extremely oblique; white; terminal area, partly suffused with pale fuscous; markings, black; a sub-basal costal dot, a larger subquadrate spot shortly beyond, and a still larger triangular spot at ⅔; a pale fuscous suffusion from ⅔ costa to tornus, with a short blackish posterior edge in middle; a second suffusion before apex, with a sharply defined posterior margin; an interrupted terminal line; cilia, white, on tornus, and apex pale fuscous. Hindwings, broadly lanceolate; grey, cilia, ½, grey.

Mt. Wellington (2500 feet), in January; Cradle Mountain (3000 feet) and Stanley, in February; three specimens.

Dryadaula melanoptycha, n. sp.

μεγανοπτυχος, with black fold.

♂. 12 mm. Head and palpi, pale ochreous-grey. Antennae, grey; ciliations, in male, minute. Thorax, fuscous. Abdomen, whitish-grey. Legs, grey; posterior pair, paler. Forewings, narrow; costa, gently arched; apex, pointed; termen, very oblique; whitish-grey, with a few scattered dark fuscous scales; a broad white dorsal streak from base, narrowing to ⅔ dorsum, edged above by an interrupted black line; cilia, whitish-grey. Hindwings, broadly lanceolate; whitish-grey; cilia, nearly 1, whitish.

Deloraine, in February; one specimen.

Dryadaula eutactopa, n. sp.

εὐτακτωπος, modest.

♂. 15 mm. Head, whitish-ochreous. Palpi, ochreous-whitish. Antennae, grey; ciliations in male, ½. Thorax, white; bases of tegulae, fuscous. Abdomen, fuscous. Legs, fuscous, with whitish rings. Forewings, narrow, suboval; costa, slightly arched; apex, round-pointed; termen, very oblique; 7 and 8 coincident; grey, with some blackish and whitish scales; a blackish plical streak broadly interrupted by two longitudinal white bars; a white median spot at ⅓, followed by some blackish irroration; a short longitudinal blackish streak at ⅔, followed by a white suffusion; cilia, whitish, with an interrupted blackish antemedian line. Hindwings, broadly lanceolate; dark grey; cilia, nearly 1, grey.

Derwent Bridge, in January; one specimen.

Erechthias ancistrosema, n. sp.

ἀγκιστροσημος, hook-marked.

♂. 10 mm. Head, whitish; lateral aspect, fuscous. Palpi, whitish. Antennae, dark fuscous; with basal pecten; ciliations, in male, minute. Thorax and abdomen, dark fuscous. Legs, fuscous; posterior pair with white rings and spurs. Forewings, narrow; apex, rounded; dark fuscous, with white markings; two fine, parallel, closely-approximated streaks from base to middle; oblique streaks from ⅓ costa and from above ⅓ dorsum, running into their apices; oblique streaks from ⅓ dorsum and from ⅔ and ⅚ costa to mid-disc; a black apical spot, edged anteriorly with whitish; cilia, fuscous; bases whitish. Hindwings, broadly lanceolate; fuscous; cilia, ⅔, grey.

Burnie, in January; one specimen.

Fam. TINEIDAE

Lepidoscia muricolor, n. sp.

muricolor, mouse-coloured.

♂. 12-14 mm. Head, palpi, antennae, thorax, abdomen, and legs, fuscous-grey. Antennal ciliations, in male, minute. Forewings, narrow, suboval; costa, straight to ¾, thence arched; apex. rounded; termen, obliquely rounded; 7 and 8, stalked; grey; cilia. grey. Hindwings with apex rounded; termen slightly rounded; grey. thinly scaled; cilia, grey.

Cradle Mountain (3000 feet), in February; seven specimens.

Narycia confluens, n. sp.

confluens, with confluent fasciae.

♂♀. 16 mm. Head, whitish. Palpi, antennae, and thorax, fuscous. Abdomen, fuscous; tuft, whitish-brown. Legs, fuscous. Forewings, suboval; costa, strongly arched; apex, round-pointed; termen, oblique; 7 and 8, stalked; white, with fuscous markings; a costal streak from base to ¼; a fascia from ¼ costa to ¼ dorsum; converging fasciae from ⅓ and ⅔ costa, uniting in mid-disc and running to a point at mid-dorsum; a fascia from ⅔ costa to tornus.

sometimes confluent on costa, with preceding and enclosing median white dots on costa and tornus; a subterminal fascia from costa to termen above tornus; terminal edge from this to apex, fuscous; cilia, fuscous, on tornus, white. Hindwings, with apex pointed; termen, slightly rounded; grey; a suffused, whitish, submarginal fascia; cilia grey.

Hobart, in October; Burnie, in January; two specimens.

Gen. **Cuphomorpha**, nov.

κουφομορφος, slightly built.

Tongue, present. Face, rough-scaled. Labial palpi, long, slender porrect or drooping; terminal joint as long as second, acute. Maxillary palpi, obsolete. Antennae longer than forewings, with strong basal pecten; in male, joints triangularly dilated at apices and shortly ciliated; in female, simple. Posterior tibiae, hairy. Forewings, with all veins present and separate. Hindwings, with 3 and 4 coincident, 6 and 7 nearly parallel.

Allied to *Macraeola* Meyr.

Cuphomorpha tanyceros, n. sp.

τανυκερως, long-horned.

♂. 16-17 mm. ♀. 14 mm. Head, thorax, and abdomen, grey. Palpi, fuscous; base and apex of terminal joint, whitish. Antennae fuscous; ciliations, in male, ⅓. Legs, fuscous; posterior pair, grey-whitish. Forewings, elongate-oval; costa, strongly arched; apex, pointed; termen, very oblique; pale, glossy grey; two rather large, ochreous-whitish, discal spots; first at ⅓, suboblong, diffusely, but partially edged with [illegible] with a broad, suffused, oblique extension nearly [illegible] Hindwings, with apex rounded; termen, only slightly rounded; pale grey; cilia, whitish-grey.

Mt. Wellington (2500 feet), in Febraury; Strahan, in January; three specimens.

Fam. HEPIALIDAE

Jeana timetea, n. sp.

τιμητεος, worthy of honour.

♂. 30 mm. Head and palpi, fuscous. Antennae, grey; pectinations in male, 2½, each ending in a long terminal bristle. Thorax, dark reddish-brown. Abdomen, fuscous; tuft, reddish-brown; under side, pale ochreous. Legs, pale ochreous; anterior pair, fuscous; all with whitish tibial hairs. Forewings, rather broadly triangular;

costa, almost straight; apex, rounded; termen, obliquely rounded; reddish-brown; some fine whitish strigulae near costa and in apical area; a pale ochreous spot on base of dorsum; basal area defined, except towards costa, by a whitish grey, slender, transverse line, curved inwards below middle of disc, and thence oblique to ¼ dorsum; in the included area are some blackish dots, partly outlined with whitish; touching this line anteriorly, are three broad longitudinal marks, first above middle contains a narrow oblique, clear, white, mark, second below middle contains a clear, white dot, third subdorsal is mixed with whitish posteriorly, a pale, ochreous, subquadrate area between upper white mark and termen, traversed by a fine, blackish, transverse line; a whitish subterminal line, preceded by several blackish spots; cilia, pale brown, interrupted by blackish and whitish dots. Hindwings, broadly spathulate; apex and termen, rounded; fuscous; cilia, pale ochreous, becoming fuscous on dorsum.

No doubt this species is variable, but it cannot be the same as *J. rubiginosa*, for, apart from the differences in colour and markings, the wings are differently shaped. In that species the ratio of breadth to length of forewing is 1 to 3, in this 1 to 2.

Derwent Bridge, in February; one specimen received from Mr. G. M. Goldfinch, who has the type.

Jeana robiginosa, n. sp.

robiginosus, rusty.

♂. 34 mm. Head and palpi, fuscous. Antennae, pale brownish; pectinations in male, 2½, each with a long terminal bristle. Thorax, fuscous; tips of hairs, whitish; some reddish hairs in middle. Abdomen and legs, fuscous. Forewings, elongate-triangular; costa, nearly straight; apex, rectangular; termen, rounded, slightly oblique; ferruginous-reddish, with grey strigulations mixed with whitish; near base, mostly grey; towards dorsum, mostly grey-whitish; a small fuscous, apical suffusion; two long, parallel, whitish strigulae before middle part of termen cilia, fuscous, mixed with reddish and barred with whitish. Hindwings, narrowly spathulate; apex and termen, rounded; fuscous; cilia, whitish-ochreous.

Waratah, in February; one specimen.

NEW LOCALITY RECORDS

These are numerous. It has become evident that a large number of species are generally distributed throughout the island, or generally distributed at lower or higher elevations. We are now able to make a commencement in designating these species, and in their case further locality records will be more cumbrous than useful. Species of general distribution should be found in all localities, except (1) high mountain tops, (2) country in which the native flora is poorly represented, (3) areas which have been extensively cleared of native vegetation.

As the range of many species depends on altitude, this should be written on their locality labels if over 1000 feet. It is not necessary to indicate variations less than 500 feet. Only a conventional line can be drawn between low and high altitudes; I suggest that this, in Tasmania, should be 1000 feet, with the proviso that on the West Coast (no doubt for climatic reasons) some usually high-level species may sometimes descend to near sea level. The line suggested may be employed to divide roughly Hobart from Mt. Wellington. The species I have recorded from 1500 feet were taken at "Fern Tree," those at 2500 feet near "The Springs," those at 4000 feet on the "Ploughed Field."

The species formerly recorded as from Moina (the nearest township) were actually taken at a higher level, "Daisy Dell," on the Cradle Mountain-road. I now record them as from Cradle Mountain 2000 feet.

LYCAENIDAE

Candalides acasta Cox, Tasman Penin.

Zizina labradus Godart, Burnie, Scottsdale. Probably generally distributed at lower levels.

Neolucia agricola Westw., Tasman Penin., Beaconsfield, Derwent Bridge. Generally distributed.

Neolucia hobartensis Misk., Derwent Bridge. Generally distributed at higher levels.

Neolucia mathewi Misk., Launceston.

NYMPHALIDAE

Heteronympha merope Fab., Mt. Wellington (1500-2500 feet), Tasman Penin., St. Marys, Derby. Generally distributed.

Heteronympha philerope Bdv., Mt. Wellington (1500 feet), Scottsdale, Deloraine, Waratah. Generally distributed.

Heteronympha cordace Hb., Derwent Bridge, Weldborough.

Xenica klugi Guerin., Mt. Wellington (1500-2500 feet), Tasman Penin., St. Marys, Weldborough, Derby, Scottsdale, Railton. Generally distributed.

Oreixenica lathoniella Westw., Mt. Wellington (1500-2500 feet), Waratah. Generally distributed.

Precis villida Fab., Hobart, Conara, St. Marys, St. Helens. Generally distributed at lower levels.

Pyrameis cardui Lin., Hobart, Derwent Bridge, Waratah, Cradle Mt. (2000-3000 feet). Generally distributed.

Pyrameis itea Fab., Ouse, Cradle Mt. (2000-3000 feet). Generally distributed.

HESPERIDAE

Anisynta tasmanica Misk., Derwent Br. Probably generally distributed.

Hesperilla donnysa Hew., Mt. Wellington (2500 feet), Tasman Penin., Bruni I. Generally distributed.

Motasingha dominula Ploetz, Derwent Br.

Taractrocera papyria Bdv., Huon.

Ocybadistis walkeri Heron, Burnie.

LARENTIADAE

Euchoeca rubropunctaria Dbld., Weldborough, Derby, Deloraine, Rosebery. Generally distributed.

Poecilasthena pulchraria Dbld., Derwent Br., Weldborough, Rosebery. Generally distributed.

Poecilasthena urarcha Meyr., Waratah.

Poecilasthena euphylla Meyr., Derwent Br.

Poecilasthena anthodes Meyr., Hobart, Scottsdale.

Chloroclystis testulata Gn., Waratah.

Chloroclystis catastreptes Meyr., St. Helens.

Chloroclystis filata Gn., Coles Bay, Triabunna. Generally distributed.

Microdes squamulata Gn., St. Marys, Derwent Br.

Chaetolopha leucophragma Meyr., Mt. Wellington (1500 feet), St. Helens, Derwent Br., Waratah. Generally distributed.

Eccymatoge callizona Low., Mt. Wellington (1500 feet).

Horisme leucophanes Meyr., Russell Falls, Scottsdale, Derwent Br., Waratah. Generally distributed.

Cidaria subochraria Dbld., Mt. Wellington (2500 feet), Derwent Br., Waratah, Burnie, Cradle Mt. (2000 feet). Generally distributed.

Cidaria uncinata Gn., Mt. Wellington (2500 feet), Coles Bay. Generally distributed.

Larentia epicrossa Meyr., Derwent Br. Generally distributed.

Epirrhoe callima Turn., Derwent Br.

Epirrhoe eustropha Turn., Waratah.

Melitulias glandulata Gn., Derwent Bridge. Generally distributed.

Euphyia epicteta Turn., Mt. Wellington (1500 feet), Scottsdale, Weldborough, Derby, Deloraine, Waratah, Derwent Bridge. Generally distributed.

Euphyia interruptata Gn., Waratah, Mt. Barrow.

Euphyia lucidulata Wlk., Derwent Br., Scottsdale. Generally distributed.

Euphyia conifasciata Butl., Derwent Br., Waratah, Derby, Burnie. Generally distributed.

Euphyia psarodes Turn., Mt. Wellington (4000 feet).

Euphyia lamprotis Meyr., Rosebery.

Euphyia anthracinata Gn., Derwent Br., Queenstown, Rosebery, Waratah. Generally distributed.

Euphyia strumosata Gn., Mt. Wellington (1500 feet), Tasman Pen., St. Marys, St. Helens, Weldborough, Derby. Generally distributed.

Euphyia heteroleuca Meyr., Mt. Wellington (1500-2500 feet), Strahan.

Euphyia vacuaria Gn., Strahan.

Euphyia leptophrica Turn., Waratah.

Euphyia perornata Wlk., Derwent Br., Waratah. Generally distributed.

Euphyia ebuleata Gn., Derwent Br. Generally distributed.

Euphyia correlata Wlk., Weldborough.

Euphyia severata Gn., Derwent Br. Generally distributed.

Acodia pauper Rosen., Scottsdale, Waratah, Strahan. Generally distributed.

Xanthorhoe heliacaria Gn., Derwent Br., Waratah, Cradle Mt. (3000 feet).

Xanthorhoe vicissata Gn., Waratah, Mt. Barrow. Generally distributed.

Xanthorhoe brujata Gn., Hobart, Russell Falls, Strahan. Generally distributed.

Xanthorhoe controneura Meyr., Mt. Wellington (1500-2500 feet), Derwent Br., Waratah, Strahan, Cradle Mt. (3000 feet). Generally distributed.

Xanthorhoe subidaria Gn., Scottsdale, Derby, Deloraine. Generally distributed.

Dasyuris polycarpa Meyr., Mt. Wellington (4000 feet).

STERRHIDAE

Eois albicostata Wlk., Tasman Penin.

Eois halmaea Meyr., Weldborough, Scottsdale. Generally distributed.

Eois philocosma Meyr., Burnie, Waratah, Rosebery, St. Marys, Coles Bay, Derby. Generally distributed.

Scopula perlata Wlk., Hobart, Strahan, St. Marys, Weldborough, Scottsdale, Waratah. Generally distributed.

Scopula liotis Meyr., Mt. Wellington (2500 feet).
Scopula rubraria Dbld. Generally distributed.
Scopula optivata Wlk., Waratah, St. Marys, Scottsdale.

GEOMETRIDAE

Euloxia gratiosata Gn., Cradle Mt. (2000-3000 feet), Derwent Br.
Euloxia meandraria Gn., Derby, Scottsdale, Launceston, Waratah, Strahan, Mole Creek. Generally distributed.
Euloxia leucochorda Meyr., Mt. Wellington (2500 feet), Mt. Barrow. Weldborough.
Iulops argocrana Meyr., Weldborough.
Chlorocoma cadmaria Gn., Waratah, Derby, St. Helens. Generally distributed.
Chlorocoma dichloraria Gn., Weldborough, Derby, Deloraine, Russell Falls, Triabunna, Coles Bay, Derwent Br., Waratah. Generally distributed.
Chlorocoma rhodothrix Turn., Rosebery.
Gelasma semicrocea Wlk., Mt. Wellington (1500 feet), Derwent Br. Generally distributed.
Gelasma calaina Turn., Mt. Barrow.
Gelasma centrophlylla Meyr., Burnie, Strahan, St. Helens. Generally distributed.
Chlorodes boisduvalaria Gn., Scottsdale, St. Helens. Generally distributed.
Crypsiphona occultaria Don., Herrick, Coles Bay. Generally distributed.

BOARMIADAE

Diastictis australiaria Gn., Coles Bay, Derby, Scottsdale. Generally distributed.
Ectropis fractaria Gn., Mt. Wellington (1500 feet), Derwent Br., Strahan, Scottsdale. Generally distributed.
Ectropis despicata Wlk., Russell Falls.
Ectropis exsuperata Wlk., Coles Bay.
Psilosticha integraria Wlk., XXI., p. 420 (*mactaria* Meyr., nec. Gn.), Coles Bay.
Boarmia epiphloea Turn., Mt. Wellington (2500 feet), Rosebery, Derwent Br.
Boarmia lyciaria Gn., Russell Falls.
Syneora mundifera Wlk., Coles Bay, Scottsdale.
Syneora symphonica Turn., St. Helens, Scottsdale.
Lyelliana pristina Turn., Mt. Wellington (2500 feet), Russell Falls, Derwent Br., Waratah, Mt. Barrow.
Metrocampa biplaga Wlk., Weldborough.
Metrocampa ada Butl., Russell Falls, Rosebery, Waratah, Weldborough, Mt. Barrow, Generally distributed.
Casbia alphitopis Turn., Mt. Wellington (1500 feet).
Casbia eccentritis Meyr., Mt. Wellington (1500 feet), Mt. Barrow. Generally distributed.
Amelora crenulata Turn., Mt. Wellington (1500 feet), Strahan, Rosebery. Generally distributed.
Amelora cyclocentra Turn., Mt. Wellington (2500 feet), Derwent Br., Cradle Mt. (3000 feet).
Amelora suffusa Turn., Mt. Wellington (2500 feet).
Amelora leucaniata Gn., Derwent Br., Strahan, Waratah, Cradle Mt. (3000 feet).
Amelora oritropha Turn., Derwent Br.
Mnesampela privata Gn., Derwent Br.
Mictodoca toxeuta Meyr., Coles Bay, Derwent Br.
Thalaina selenaea Dbld., Coles Bay.
Thalaina inscripta Wlk., Russell Falls, St. Marys, Derwent Br. Generally distributed.
Conosara castaneata Meyr., Russell Falls.
Chlenias banksiaria Le Guil., Waratah.
Chlenias zonaea Meyr., Russell Falls.
Archephanes zalosema Turn., Mt. Wellington (2500-4000 feet), Derwent Br.
Hypsitropha euschema Turn., Derwent Br., Strahan, Rosebery.
Drymoptila temenitis Meyr., Strahan.

OENOCHROMIDAE

Taxeotis intextata Gn., Launceston.

Taxeotis oraula Meyr., Hobart, Mt. Wellington (1500-2500 feet), Coles Bay, Derwent Br., Hellyer Gorge, Wilmot. Generally distributed.

Dichromodes stilbiata Gn., St. Helens, Derwent Br. Generally distributed.

Adeixis inostentata Derwent Br.

NOTODONTIDAE

Teara periblepta Turn., Rosebery, Derwent Br.

Gallaba eugraphes Turn., Mt. Wellington (2500 feet).

ARCTIADAE

Thermeola tasmanica Hmps., Mt. Wellington (1500-2500 feet). The locality Hobart may be an error.

Scoliacma bicolor Bdv., Hobart.

Phaeophebosia furcifera Wlk., Waratah.

Palaeosia bicosta Wlk., Coles Bay, Weldborough, Deloraine, Waratah. Generally distributed.

Halone sejuncta Feld., St. Helens, Derby, Burnie.

Caprimima sicciodes Hmps., Rosebery, Waratah.

Caprimima procrena Meyr. Generally distributed.

Thallarcha epiostola, Stanley.

Castulo doubledayi Newm., Russell Falls, Coles Bay, Derby, Wilmot. Generally distributed.

Ardices glatignyi Le Guil., Mt. Wellington, Rosebery, Strahan, Waratah.

Ardices curvata Don. subsp. *vigens* Butl. I., Georgetown.

NOLIDAE

Celama tholera Turn., Burnie.

Celama albalis Wlk., Derwent Br.

Celama paromoea Meyr., Waratah.

Nola cycota Meyr., Coles Bay, St. Marys, Queenstown, Derwent Br.

Nola aulocota Meyr., Mt. Wellington (2500 feet).

Nola macrorrhyncha Turn., Mt. Wellington (1500 feet), Weldborough, Mt. Barrow, Waratah.

Roeselia lugens Wlk., Russell Falls, Waratah.

NOCTUIDAE.

AGARISTINAE.

Phalaenoides glycinae Lew., Hobart, Beaconsfield.

Phalaenoides tristifica Hb., Strahan.

Hecatesia fenestrata Bdv., Hobart, Rosebery.

AGROTINAE.

Euxoa porphyricollis Gn., Waratah, Cradle Mt. (3000 feet).

MELANCHRINAE.

Sideridis ewingii Westw., Mt. Wellington (2500 feet), Deloraine, Cradle Mt. (3000 feet).

Dasygaster hollandiae Gn., Mt. Wellington (2500 feet), Waratah, Devonport.

CUCULLIANAE.

Eumichtis saliaris Gn., Waratah. Generally distributed.

ACRONYTINAE.

Euplexia iorrhoa Meyr., Mt. Wellington (1500-2500 feet).
Euplexia nigerrima Gn., Mt. Wellington (2500 feet).
Amphipyra sanguinipuncta Gn., Mt. Wellington (1500 feet), Burnie.
Caradrina capularis Gn. Weldborough, Derby, Scottsdale.

NOCTUINAE.

Alapadna pauropis Turn., Weldborough, Derby.
Artigisa lignicolaria Wlk., Rosebery, Strahan, Derwent Br.
Rhodina falculalis Gn., Hobart, Tasman Penin.

LYMANTRIADAE

Acyphas leucomelas Wlk., Burnie.

ANTHELIDAE

Anthela connexa Wlk., Rosebery, Scottsdale, Cradoc.

ZYGAENIDAE

Pollanisus lithopastus Turn., Derwent Br., St. Marys, Waratah.
Pollanisus viridipulverulentus Guer., Derwent Br.
Neoprocris dolens Wlk., Derwent Br., Derby.

PHYCITIDAE

Homoeosema fornacella Meyr., Derwent Br.
Unadilla distichella Meyr., Burnie.
Sclerobia tritalis Wlk., Launceston, Railton, Deloraine, St. Marys, Derby. Generally distributed at lower levels.

GALLERIADAE

Heteromicta pachytera Meyr., Launceston.

CRAMBIDAE

Platytes pentadactyla Zel., Waratah.
Chilo lativittalis Wlk., Tasman Penin., Derwent Br.
Talis relatalis Wlk., Tasman Penin., Scottsdale. Generally distributed.
Talis orthotypa Turn., Derwent Br.
Talis epulentella Zel., Mt. Wellington (2500 feet), Russell Falls.
Talis grammella Zel., Waratah, Weldborough, Derby. Generally distributed.

SCHOENOBIADAE

Scirpophaga patulella Wlk., Tasman Penin., Weldborough, Derby, Scottsdale, Waratah. Generally distributed.

PYRALIDAE

Diplopseustis perieresalis Wlk., Hobart, Mt. Wellington (2500 feet), Scottsdale, St. Helens, Strahan.
Spcetratrota fimbrialis Warr., Tasman Penin., Beaconsfield, Coles Bay.
Macalla marmorea Warr., Launceston, Deloraine, Coles Bay, Penguin, Derwent Br.
Epipaschia amauropis Turn., Mt. Wellington (1500 feet), Derwent Br., Rosebery, Burnie, Wilmot, Scottsdale. Generally distributed.
Epipaschia costigeralis Wlk., Mt. Wellington (2500 feet).

PYRAUSTIDAE

Hydreuretis oxygramma Turn., Deloraine.
Nymphula nitens Butl., Deloraine.
Musotima nitidalis Wlk., Burnie, Queenstown, Derby, Scottsdale.
Nacoleia rhoeonalis Wlk., St. Marys, Derby.

Hellula undalis Gn., Hobart.
Metasia liophaea Meyr., Hobart, St. Marys.
Metasia capnochroa Meyr., Rosebery.
Pyrausta hyalistis Low., Weldborough.
Heliothela persumptana Wlk., Hobart.
Eclipsiodes drosera Meyr., Hobart, Strahan, Derwent Br., Waratah.
Scoparia favilliferella Wlk., Tasman Pen., Derwent Br., Waratah. Generally distributed.
Scoparia philonephes Meyr., Derwent Br., Cradle Mt. (3000 feet), Mt. Barrow.
Scoparia cleodoralis Wlk., Waratah, Weldborough. Generally distributed.
Scoparia syntaracta Meyr., Waratah. Generally distributed.
Scoparia spelaea Meyr., Mt. Wellington (2500 feet), Tasman Pen., Waratah. Generally distributed.
Scoparia gomphota Meyr., Mt. Wellington (2500 feet).
Scoparia anthracias Meyr., Queenstown, Derwent Br. Generally distributed.
Scoparia plagiotis Meyr., Mt. Wellington (1500-2500 feet), King R. Gorge, Waratah, Mt. Barrow. Generally distributed.

PTEROPHORIDAE

Platyptilia omissalis Fletcher, Hobart, St. Marys, Launceston. Generally distributed.
Platyptilia phaeonephes Meyr., Waratah.

PHALONIADAE

Heliocosma incongruana Wlk., St. Marys, Weldborough. Generally distributed.

TORTICIDAE

Proselena annosana Meyr., Hobart, Stanley.
Acropolitis rudis Wlk., Stanley.
Isochorista chaodes Meyr., Derwent Br.
Batodes conjunctana Wlk., Derby.
Capua poliobaphes Turn., Tasman Pen., St. Marys, Scottsdale, Burnie, Wilmot. Generally distributed.
Capua euphona Meyr., Tasman Pen., Derwent Br. Generally distributed.
Capua eugrapta Turn., Tasman Pen.
Capua nimbosa Turn., Hobart.
Capua clarana Meyr., Tasman Pen., Coles Bay, St. Marys, Derwent Br. Generally distributed.
Capua montivagana Meyr., St. Marys. Generally distributed.
Capua mersana Wlk., Derby, Rosebery. Generally distributed.
Capua intractana Wlk., Mt. Wellington (2500 feet), Tasman Pen., Derby, Scottsdale, Burnie. Generally distributed.
Capua placoxantha Low, Weldborough.
Cacoecia polygraphana Wlk., Tasman Pen., Coles Bay, Rosebery. Generally distributed.
Tortrix xylodes Meyr., Waratah. Generally distributed.
Tortrix ashworthana Newm., Derby, Waratah.
Tortrix psapharana Meyr., Strahan, Waratah, Burnie.
Tortrix postvittana Wlk., Waratah. Generally distributed.
Tortrix caryotis Meyr., Hobart, Derwent Br., Waratah, Cradle Mt. (3000 feet). Generally distributed.
Tortrix eurystropha Turn., Mt. Wellington, Strahan, Waratah.
Tortrix incompta Turn., Waratah.
Tortrix ophiodesma Low, Mt. Wellington (1500-2500 feet), Rosebery.
Tortrix fabricata Meyr., Mt. Wellington (2500 feet), Rosebery.
Tortrix sobriana Wlk., Scottsdale.
Tortrix plastica Meyr., Waratah. Generally distributed.
Tortrix astathmeta Turn., Waratah.

Tortrix lythrodana Meyr., Derwent Br. Generally distributed.
Tortrix laganodes Meyr., Mt. Wellington (1500 feet).
Tortrix stigmatias Meyr., Mt. Wellington (2500 feet), Weldborough.
Tortrix psarodes Meyr., Mt. Wellington (3000 feet).
Tortrix subfurcatana Wlk., Tasman Pen., Weldborough, Derby, Waratah. Generally distributed.
Tortrix tasmaniana Wlk., Tasman Pen.
Tortrix eucela Meyr., Mt. Wellington (2500 feet).
Tortrix liquidana Meyr., Mt. Wellington (2500 feet), Tasman Pen., St. Marys, Derwent Br., Waratah. Generally distributed.
Tortrix indigestana Meyr., Tasman Pen.
Tortrix concordana Meyr., St. Marys.
Tortrix concolorana Meyr., Mt. Wellington (2500 feet), St. Marys, Weldborough
Tortrix divulsana Wlk., Waratah. Generally distributed.
Epichorista serena Meyr., Pt. Davey.
Cnephasia contortula Turn., Mt. Wellington (2500 feet).
Cnephasia gnophodryas Low, Mt. Wellington (1500-4000 feet), Strahan, Waratah.
Scolioplecta comptana Wlk., Coles Bay. Generally distributed.

EUCOSMIDAE

Spilonota ejectana Wlk., Tasman Pen., Herrick, Derby, Railton. Generally distributed.
Spilonota macropetana Meyr., Triabunna.
Acroclita fidana Meyr., Derwent Br.
Acroclita perspectana Wlk., Tasman Pen., Strahan.
Eucosma triangulana Meyr., Mt. Wellington (1500-2500 feet).

ELACHISTIDAE

Labdia semnostola Meyr., Strahan.
Hoplophanes phaeochalca Meyr., Rosebery, Strahan.
Coleophora deauratella Zel., Mt. Wellington (2500 feet)., St. Marys, St. Helens, Devonport. Generally distributed.

GELECHIADAE

Megacraspedus niphodes Low, Waratah.
Megacraspedus popularis Meyr., Derwent Br.
Aristotelia furtiva Meyr., Coles Bay.
Aristotelia centrosema Low, Burnie.
Thiotricha parthenica Meyr., Deloraine, Derby.
Phthorinaea operculella Zel., Derby.
Epimimastis porphyroloma Low, Derwent Br.
Crocanthes glycina Meyr., Tasman Pen., Coles Bay.
Hyodectis crenoides Meyr., Rosebery.

XYLORYCTIDAE

Xylorycta parabolella Meyr., Derwent Br.
Xylorycta argentella Wlk., Tasman Pen.
Agriophara diminuta Rosen., Hobart.
Agriophara cinerosa Rosen., Derwent Br., Brunie.

OECOPHORIDAE

Endrosis lactella Schif., Waratah. Generally distributed.
Borkhausenia oxypeuces Turn., Coles Bay.
Borkhausenia canephora Meyr., Queenstown, Waratah. Generally distributed.
Borkhausenia anthemodes Meyr., Mt. Wellington (2500 feet), Derwent Br., Strahan.
Locheutis philochlora Meyr., Mt. Wellington (1500 feet), Rosebery, Waratah, Cradle Mt. (3000 feet).

Locheutis dolichotricha Turn., Mt. Wellington (1500-2500 feet).

Trachypepla capsellata Meyr., Hobart, Mt. Wellington (1500 feet), St. Marys, St. Helens. Generally distributed.

Eucryphaca phoenochyta Turn., Rosebery, Cradle Mt. (3000 feet).

Barea arbitra Meyr., Hobart, Mt. Wellington (1500-2500 feet), Russell Falls, Derwent Br., Gordon R. Generally distributed.

Barea asbolaea Meyr., Mt. Wellington (1500 feet), Scottsdale, Waratah. Generally distributed.

Barea hypcrarcha Meyr., Mt. Wellington (1500-2500 feet), Scottsdale, Coles Bay.

Barea micropis Meyr., Mt. Wellington (1500 feet), St. Marys.

Barea psalogramma Turn., Tasman Pen., Mt. Barrow.

Barea psephophora Meyr., Derwent Br., Strahan, Rosebery. Generally distributed.

Barea epithistis Meyr., Triabunna, Scottsdale, Devonport. Generally distributed.

Eulechria habrophanes Meyr., Hobart.

Eulechria poecilella Meyr., Triabunna.

Eulechria xylopterella Meyr., St. Helens.

Eulechria aerodes Meyr., Launceston.

Eulechria hemiphanes Meyr., Beaconsfield.

Eulechria sthenopis Turn., Mt. Wellington (1500-2500 feet), Strahan, Rosebery, Waratah, Scottsdale, Weldborough. Generally distributed.

Eulechria mesophragma Meyr., St. Marys.

Eulechria adoxella Meyr., Bothwell, Strahan.

Eulechria pastea Turn., Burnie, Cradle Mt. (3000 feet).

Machima leucerythra Meyr., Hobart, Russell Falls, Railton. Generally distributed.

Machimia miltopsara Turn., Mt. Wellington (1500 feet).

Machaeretis pelinopa Meyr., Derwent Br., Burnie, Weldborough.

Machaeretis aegrella Meyr., Derwent Br. Generally distributed.

Machaeretis psathyra Meyr., Mt. Wellington (1500 feet).

Haplodyta thoracta Meyr., Tasman Pen., Derwent Br.

Ocystola crystallina Meyr., Railton.

Oxythecta nephelonota Meyr., Waratah, Derwent Br. Generally distributed.

Deuterogonia acroxantha Meyr., Mt. Wellington (2500 feet), Derwent Br. Generally distributed.

Aristeis chrysoteuches Meyr., Hobart, Mt. Wellington (1500 feet).

Coesyra stenoptera Meyr., St. Marys.

Coesyra parvula Meyr., Rosebery. Generally distributed.

Coesyra ophthalmica Meyr., St. Marys, Weldborough.

Coesyra anthodora Meyr., Strahan.

Coesyra ochrocirrha Turn., Gordon R.

Coesyra aclea Meyr., Rosebery. Generally distributed.

Pleurota chlorochyta Meyr., Tasman Pen., St. Marys, Derwent Br. Generally distributed.

Pleurota endesma Meyr., Mt. Wellington (1500-2500 feet), Scottsdale, Weldborough, Strahan, Waratah, Burnie. Generally distributed.

Pleurota themeropis Meyr., Deloraine.

Pleurota psephena Meyr., Gordon R., Waratah.

Opsitycha squalidella Meyr., Tasman Pen.

Thalerotricha mylicella Meyr., Hobart.

Philobota auriceps Butl. It is doubtful whether this species occurs in Tasmania. Most, and perhaps all, former records should, I think, be referred to *P. chrysosticha*, which is here described.

Philobota olympias Meyr., Launceston.

Philobota atmobola Meyr., Tasman Pen., St. Marys, Waratah. Generally distributed.

Philobota aeolias Meyr., Weldborough, Waratah.

Philobota charaxias Meyer., Hobart, Mt. Wellington (1500-2500 feet), Tasman Pen.

Philobota placochorda Turn., Waratah.

Philobota aurinatella, Derwent Br.

Philobota cirrhodes Meyr., Derby.

Philobota ceratina Meyr., Mt. Wellington (1500-2500 feet).
Chrysonoma atricollis Meyr., Hobart.
Chezala glaphyropla Meyr., Coles. Bay.
Enchronista bathrosticha Turn., Mt. Wellington (1500 feet), Cradle Mt. (3000 feet).
Zonopetala erythrosema Meyr., St. Marys.
Zonopetala quadripustulella Wlk., Hobart.
Heliocausta elaeodes Meyr., Derwent Br.
Heliocausta coenosa Meyr., Russell Falls.
Lepidotarsa chrysopoca Meyr., Rosebery, Herrick.
Tortricopsis uncinella Zel., Weldborough, Scottsdale. Generally distributed.
Thudaca trabeata Wlk., Tasman Pen., Derwent Br. Generally distributed.
Thudaca obliquella Wlk., Derwent Br. Generally distributed.
Thudaca innubila Turn., Derwent Br.
Eutorna leptographa Meyr., Hobart, St. Marys, Weldborough, Burnie. Generally distributed.
Eutorna eurygramma Meyr., Rosebery, Weldborough.
Eutorna diaula Meyr., Hobart, Queenstown, Burnie. Generally distributed.
Cryptolechia lewinella Newn., Hobart.
Cryptolechia radiosella Wlk., Hobart.
Cryptolechia lutea Turn., Strahan, Stanley.
Cryptolechia argillea Turn., St. Marys, Weldborough, Beaconsfield, Railton.

HELIODINIDAE

Stathmopoda cephalaea Meyr., Mt. Wellington (1500 feet). Larvae feeding in galls on *Acacia decurrens* and on another unidentified species of *Acacia*. Triabunna.

GLYPHIPTERYGIDAE

Cebysa leucoteles Wlk., Richmond.
Choreutis lampadias Meyr., Mt. Wellington (2500-4000 feet), Derwent Br., Waratah.
Choreutis homotypa Meyr., Mt. Wellington (2500 feet), Derwent Br.
Glyphipteryx macraula Meyr., Hobart, Mt. Wellington (2500 feet), Burnie.
Glyphipteryx tetrasema Meyr., Mt. Wellington (2500 feet), Derwent Br.
Glyphipteryx asteriella Meyr., Waratah.
Glyphipteryx calliscopa Low, Rosebery, Waratah.
Glyphipteryx leucargyra Turn., Tasman Pen., Strahan.
Glyphipteryx gypsonota Turn., Tasman Pen., Strahan, Cradle Mt. (3000 feet).

HYPONOMEUTIDAE

Zelleria mystarcha Meyr., Mt. Wellington (2500 feet).
Zelleria citrina Meyr., Queenstown, Rosebery.

COPROMORPHIDAE

Hypertropha tortriciformis Gn., Coles Bay, Derwent Br.

CARPOSINIDAE

Bondia nigella Newm., Mt. Wellington.
Carposina petraea Meyr., Mt. Wellington (2500 feet).
Paramorpha semotheta Meyr., Derwent Br.

PLUTELLIDAE

Phalangitis tumultuosa Meyr., Weldborough.

ERECHTHIADAE

Leucoptera chalchocycla Meyr., Mt. Wellington (2000-2500 feet), Launceston, Burnie.
Leucoptera deltidias Meyr., Hobart, Mt. Wellington (2500 feet), Waratah.
Opogona comptella Wlk., Mole Creek. Generally distributed.
Opogona stereodyta Meyr., Derwent Br., Rosebery. Generally distributed.
Dascia sagittifera Meyr., St. Helens.

TINEIDAE

Narycia adelopis Meyr., Hobart.

Narycia phaulodes Meyr. (erroneously given as *phauloptera* in the first revision). Hobart.

Narycia retinochra Low, Deloraine. Generally distributed.

Mesopherna palustris Meyr., Hobart.

Lindeera tessellatella Blanch., Hobart.

Monopis ethelella Newn., Waratah, Cradle Mt. (3000 feet). Generally distributed.

Tinea irruptella Wlk., Derwent Br.

Tinea ochranthes Meyr., Coles Bay, Beaconsfield.

ADELIDAE

Nemotois sparsella Wlk., St. Marys, Derwent Br.

PAP. & PROC. ROY. SOC. TASMANIA, 1938 (14th April, 1939)

Tasmanian Parastacidae

By

ELLEN CLARK

(Read 14 November, 1938)

PLATES XII-XIII

Freshwater and land crayfishes of the family Parastacidae are found in most countries of the Southern Hemisphere. They occur abundantly throughout Tasmania, eleven species, contained in four genera, being known. In the following pages each of these is described and figured, making a complete list of the Tasmanian members of the family.

The genus *Astacopsis*, which includes the largest known species, is aquatic, each of the three species inhabiting both rivers and lakes, *A. tricornis* Clark being known only from the Lake St. Clair district.

It is interesting to find specimens of *Geocharax*, a semi-aquatic genus found throughout Victoria and on Kangaroo Island, occurring at Smithton on the north coast. The closely allied, semi-aquatic genus *Cherax* has not been found in Tasmania, although it is found abundantly in each State on the mainland of Australia, in New Guinea and in the Aru Islands.

Four species of the land-dwelling crayfishes *Engaeus* are found in the northern half of the island, but none has been found in the southern half. Several species of the genus occur in Victoria and one on King Island.

Parastacoides, a land-dwelling genus containing three species, is found in the extreme south-west of the island and on the south and west coasts.

The distribution of the various genera and species cannot be mapped out satisfactorily at present. Comparatively little collecting has been done with this family, particularly in the southern half of the island. The material collected by the recently-formed

Tasmanian Biological Survey, however, has enabled me to record specimens from many additional localities, and undoubtedly further collecting will add considerably to our knowledge of the distribution of these animals.

My research work on this group, which was carried out at the National Museum, Melbourne, was made possible by a grant from the trustees of the Commonwealth Research and Endowment Fund.

Genus **Geocharax** Clark

Geocharax Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 31.

Carapace higher than broad, punctate or tuberculate. Cervical groove deeply impressed, rounded. Rostral carinae smooth. Abdomen smooth, punctate, or setose; lateral margins rounded. Stem of each podobranch laterally produced into a small wing-like expansion bearing a few hooked filaments. Gill formula 21 + ep.r.

Geocharax gracilis Clark

Pl. XII, figs. 1, 1a, 1b

Geocharax gracilis Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 31, pl. vi., fig. 26.

The rostrum is long and slender; the lateral carinae very sharp; and the interantennal spine short and broad, sharply pointed. The sternal keel is slender and sharp. The pereopods are very slender, and the great chelae short and slender. Length of adult specimens 63 mm.

Three specimens from Smithton, collected by Miss J. Fenton, and one specimen from a shallow stream near Smithton, collected by J. W. Evans. This species is found also in the Gellibrand River, south of Colac, Victoria (type locality) (W. F. Hill); Portland, Victoria (L. R. Kurtze); and on Kangaroo Island, South Australia (South Australian Museum).

Genus **Astacopsis** Huxley

Astacus, Gray, *Eyre's Journ. Exped. Disc. Centrl. Austrl.*, i, (Appendix), 1845, p. 409; von Martens, *Monatsber. Akad. Wiss. Berlin*, 1868, p. 615.

Astacopsis, Huxley, *Proc. Zool. Soc. Lond.*, 1878, p. 764; Smith, *Trans. Linn. Soc. Lond.*, ser. 3, xi., 1908, Zool., p. 70; Haswell, *Cat. Austrl. Mus., Crust.*, 1882, p. 175; Smith, *Proc. Zool. Soc. Lond.*, 1912, p. 154; Faxon, *Proc. U.S. Nat. Mus.*, xx., 1898, p. 639; Faxon, *Mem. Mus. Comp. Zool.*, xl., 8, 1914, p. 402; Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 33.

Carapace with numerous small tubercles and punctures. Cervical groove deeply impressed, rounded. Rostrum broad, carinae blunt, tuberculate. Abdomen smooth, or punctate, lateral margins pointed, usually with spines on lateral margins of only the first and second segments. First segment with lateral lobes large and rounded. Stems of podobranchs without broad wing-like expansions. Gill formula 21 + ep.r.

Astacopsis franklinii (Gray)

Pl. XII, figs. 2, 2a, 2b

Astacus franklinii Gray, *Eyre's Journ. Exped. Disc. Cent. Austrl.*, i. (Appendix), 1845, p. 409, t. 3, f. 1; Erichson, *Arch. f. Naturg.*, xii., 1846, p. 375; White, *List Crust. Brit. Mus.*, 1847, p. 72; von Martens, *Monats. Akad. Wiss. Berlin*, 1868, p. 616.

Astacopsis franklinii, Haswell, *Cat. Austrl. Mus., Crust.*, 1882, p. 176; Thomson, *Pap. Roy. Soc. Tas.*, 1892 (1893), p. 50: Faxon, *Proc. U.S. Nat. Mus.*, xx., p. 669, 1898; Ortmann, *Proc. Amer. Philos. Soc.*, xli., p. 292, 1902; Faxon, *Mem. Mus. Comp. Zool.*, xl., 8, 1914, p. 402: Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 34, pl. vii., fig. 27.

The rostrum is broad, the carinae blunt, with several small tubercles. The squame of the second antennae with three to five small, sharp spines on the outer margin. The interantennal spine is long and broad, sharply pointed, with the lateral margins serrated. The branchiostegites and the anterior of the carapace are studded with numerous small tubercles. The great chelae are short and stout, the upper surface being covered with numerous small tubercles and punctures. Length of adult specimens 127 mm.

Habitat: Saundridge (A. Bartholomew); Hobart (V. Hickman).

Local Variety.

Several specimens from the Mt. Wellington district, received from the Tasmanian Biological Survey, differ from the typical *franklinii*, in having the squame of the second antennae smooth, and the upper surface of the great chelae less tuberculate.

Habitat: Hobart Creek, Mt. Wellington; Cascade Creek, Mt. Wellington (D. Turner); Ridgeway (D. Tagg).

Astacopsis gouldi Clark

Pl. XII, figs. 3, 3a, 3b

Astacus sp. Gould, *Pap. Roy. Soc. Tas.*, 1870 (1871), p. 42.

Astacopsis franklinii. Huxley, *Proc. Zool. Soc. Lond.*, 1878, p. 764; Smith, *Trans Linn. Lond.*, ser. 2, xi., Zool., p. 70, 1908; Smith, *A Naturalist in Tasmania*, 1909, p. 110, fig. 30; Smith, *Proc. Zool. Soc. Lond.*, p. 154, 1912, pl. xiv.

Astacopsis gouldi Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 35, pl. vii., fig. 28.

The rostrum is broad, the apex sharp, carinae rounded, each with three or four tubercles; there is a sharp, longitudinal carina in the centre of the rostrum continued backward from the apex about half-way to the base. The squame of each second antenna is large and smooth. The interantennal spine is rather long and narrow, sharply pointed, the lateral margins being either smooth or serrated. The branchiostegites and the anterior of the carapace with a few small scattered tubercles. The great chelae are very stout, the apex of both the propodus and the dactylus being densely tuberculate or spinous.

Habitat: Circular Head (J. Leadbeater) (type locality); Zeehan; Gordon River; Brid and Muddy Creeks, Bridport; Macquarie Harbour; Wynyard.

This is the giant Tasmanian crayfish, adult specimens of which measure up to 405 mm. in length, measured from the tip of the rostrum to the end of the telson. The species may be recognised readily by the conspicuous longitudinal carina in the centre of the rostrum. Immature specimens, 127 mm. long, show every detail of the adult armature.

Astacopsis tricornis Clark

Pl. XII, figs. 4, 4a, 4b

Astacopsis tricornis Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, pl. i, fig. 7; pl. vii., fig. 29.

Length of largest specimen 140 mm.

Rostrum broad, slightly longer than the breadth at base, carinae large and blunt, with four or five tubercles, apex of rostrum and carinae each produced into comparatively long, bluntly-pointed spines; a sharp spine and a small tubercle at base of carinae, with a large, rounded boss postero-laterally.

Eyes large. Squame of each second antenna reaching almost to end of third segment of second antennae, broad and sharply pointed. Interantennal spine short and broad, apex long and sharp, lateral margins serrated.

Carapace shorter than abdomen, broader than high, slightly more than twice as long as broad; cervical groove deeply impressed, branchio-cardiac grooves feeble; areola broad; surface of entire carapace densely punctate. Branchiostegites and anterior of carapace densely tuberculate.

Sternal keel slender; lateral processes erect, slender and sharp, posterior pair deeply grooved; a large, deep opening under lateral processes, largest on third and fourth pairs; processes between fourth pereopods long and stout.

First abdominal segment with a sharp spine on each lateral lobe; second segment with several sharp spines along lateral margins, several tubercles and spines above the lateral spines; lateral margins of all following segments each produced to sharp points. One or two rows of small tubercles on dorso-lateral margins of each segment.

Telson one and one-third times as long as broad, with a spine on each lateral margin at posterior third. Uropods rounded, longer than telson, inner rami each divided by a feeble longitudinal median carina ending in a small spine near posterior margin; outer rami each with transverse suture at apical third, one large and several small, spines along the suture; lobes at base of uropods rounded, without spines.

Great chelae stout; propodus two and one-half times as long as broad, punctate, upper margin with several sharp spines, lower margin with two rows of blunt spines, three or four tubercles on both upper and lower surfaces near base of dactylus, cutting edge with two or three small tubercles; dactylus stout, with two rows of small, blunt spines on upper margin, cutting edge with two or three small tubercles, a row of small tubercles on upper surface, just above cutting edge. Carpus with one large, sharp spine and two or three small blunt spines on upper margin; merus with several sharp spines on upper margin.

Habitat: Lake St. Clair (B. Spencer) (type locality); Cradle Mountain; Lake St. Clair district, from a creek running into the Derwent River, one mile from Derwent Bridge (Handley); mouth of Cuvier River, Lake St. Clair (A. W. S. Powell).

As the type of this species is only 105 mm. in length, and larger specimens show several variations in character, due to size and age, the species has been redescribed and figured from a larger specimen taken from the Cuvier River, and received from the Tasmanian Biological Survey.

All the localities from which *A. tricornis* has been received are in the Lake St. Clair district or from the rivers leading from it; the altitude in this district is between 2000 feet and 3000 feet.

This is the most spinous of all the Tasmanian species; the abdomen of the largest specimens showing indications of rows of tubercles or spines, which suggest that larger specimens may be found with well-developed spines and tubercles on the abdomen similar to those in the species of *Euastacus*, occurring in the rivers of eastern Australia.

Great variation is shown in the armature of the series examined. The spines on the great chelae and carpus vary considerably, even on the same individual, and this applies also to the spines on the abdomen. Four of the specimens have a small spine near the centre of the outer margin of the squame of the second antennae.

Genus **Engaeus** Erichson

Astacus (*Engaeus*) Erichson, *Arch. f. Naturg.*, xii., 1846, p. 102.
Astacus, von Martens, *Monats. Akad. Wiss. Berlin*, p. 618, 1868.
Engaeus. Huxley, *Proc. Zool. Soc. Lond.*, 1878, p. 769; Haswell, *Cat. Austrl. Mus., Crust.*, p. 178, 1882; Faxon, *Proc. U.S. Nat. Mus.*, xx., 1898, p. 670; Faxon, *Mem. Mus. Comp. Zool.*, xl., 8, 1914, p. 403; Smith and Schuster. *Proc. Zool. Soc. Lond.*, 1913, p. 118; Clark, *Mem. Nat. Mus., Vict.*, 10, 1936, p. 37.

Carapace higher than broad, punctate or feebly tuberculate, cervical groove either feeble or moderately well impressed, somewhat V-shaped. Rostral carinae smooth or feebly tuberculate. Abdomen smooth, punctate or setose; lateral margins rounded. First segment without lateral lobes. Stems of podobranchs without winglike expansions. Posterior pleurobranch usually well developed, sometimes rudimentary. Gill formula 21 + ep.r.

Engaeus cunicularius Erichson

Pl. XII, figs. 5, 5a, 5b

Astacus (*Engaeus*) *cunicularius* Erichson, *Arch. f. Naturg.*, xii., 1846, p. 102.
Astacus cunicularius Er., von Martens, *Monats. Akad. Wiss. Berlin*, 1868, p. 169.
Engaeus cunicularius Er., Haswell, *Cat. Austrl. Mus., Crust.*, 1882, p. 179; Thomson, *Pap. Roy. Soc. Tas.*, 1892 (1893), p. 50, pl. 1, figs, 1-2; Faxon, *Proc. U.S. Nat. Mus.*, xx., 1898, p. 676; Ortmann, *Proc. Amer. Phil. Soc.*, xli., 1902, p. 292; Smith and Schuster, *Proc. Zool. Soc. Lond.*, p. 124, 1913; Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 38, pl. viii., fig. 35.

The rostrum is broad, reaching to base of third segment of first antennae, the apex blunt; the carinae are sharp and carried well back on to the carapace. The squame of each second antenna is large and sharply pointed. The interantennal spine is triangular and bluntly pointed. The sternal keel is narrow and very sharp. The great chelae are slender, with a few feeble tubercles on the upper margin, and the lower margin smooth.

Habitat: Glenore, near Hagley (A. Bartholomew); Launceston (A. Bartholomew); Mundan Farm, Longford (A. Bartholomew); South Esk River, Longford, taken from the stomach of a brown trout (P. L. Andrews).

Engaeus leptorhynchus, sp. nov.

Pl. XIII, figs. 6, 6a, 6b

Length of largest specimen 40 mm.

Rostrum very slender, reaching to base of third segment of first antennae, apex sharp; carinae sharp, carried well back on to carapace.

Squame very long and slender, reaching almost to end of third segment of second antennae, terminal spine sharp. Interantennal spine short and broad, bluntly pointed. Exopods of third maxillipedes rudimentary.

Sternal keel broad, bluntly rounded, between first and third pereopods; first three pairs of lateral processes small and blunt, processes between third pereopods not flattened, deeply grooved, margins blunt; processes between fourth pereopods long and slender. There are no openings on any of the lateral processes.

Telson narrowly cone-shaped, without spines on the lateral margins, shorter than uropods; inner rami of uropods rounded, divided by a longitudinal median carina, tapering away at posterior margin; outer rami rounded, divided by a longitudinal median carina, ending in a sharp spine on the transverse suture, the transverse suture placed at the posterior third of uropod, several small sharp spines along the suture.

Great chelae short and stout, punctate and setose; propodus twice as long as broad, with a row of tubercles on upper margin, lower margin smooth, two or three small tubercles along cutting edge, a smooth carina on both upper and lower surface above cutting edge; dactylus slender, punctate and setose, with one or two small tubercles on cutting edge, two smooth carinae along upper margin, a smooth carina on both upper and lower surfaces above cutting edge. Carpus with numerous small tubercles on upper margin, upper margin of merus with a feebly tuberculate carina.

Posterior pleurobranch well developed.

Habitat: Pioneer Mine, Derby (A. Bartholomew) (type locality); Bradshaw's Creek, three miles from Herrick.

Types in the National Museum, Melbourne.

Near *E. cunicularius* Er., in general appearance, but it may be separated readily by the slender rostrum and squame, the form of the sternal keel, and by the great chelae.

Engaeus fossor Erichson

Pl. XIII, figs. 7, 7a, 7b

Astacus (*Engaeus*) *fossor* Erichson, *Arch. f. Naturg.* xii., 1846, p. 102.

Astacus fossor Er., von Martens, *Monats. Akad. Wiss. Berlin*, 1868, p. 618.

Engaeus fossor Er., Haswell, *Cat. Austrl. Mus., Crust.*, 1882, p. 178; Faxon, *Proc. U.S. Nat. Mus.*, xx., 1898, p. 676; Ortmann, *Proc. Amer. Phil. Soc.*, xli., 1902, p. 292; Smith and Schuster, *Proc. Zool. Soc. Lond.*, 1913, p. 119; Faxon, *Mem. Mus. Comp. Zool.*, xl., 8, 1914, p. 403.

Length of average adult specimen 75 mm.

Rostrum short and broad, reaching to base of second segment of first antennae, apex broadly rounded; carinae blunt, continued to apex, carried well back on to carapace.

Squame of second antennae short and very broad, with a small, sharp point. Interantennal spine short, broad posteriorly, sharply pointed. Exopods of third maxillipedes indicated by a small papilla.

Sternal keel slender and sharp between great chelae and second pereopods, obsolete between second and third pereopods. First two pairs of lateral processes small, somewhat flattened, each with a small, round opening on upper surface; processes between second pereopods large, upper margin rather sharp, a deep groove separating the pair, each with a conspicuous large, round opening; processes between third pereopods somewhat flattened, deeply grooved in centre, each with a small, oval opening along outer margin; processes between fourth pereopods long and slender.

Telson broadly cone-shaped, as long as uropods, with a spine on lateral margins; inner rami of uropods rounded, divided by a longitudinal median carina, tapering away at posterior margin; outer rami rounded, divided by a longitudinal median carina, ending in a sharp spine on the traverse suture, the suture placed at posterior third of uropods, several small spines along the suture.

Great chelae large and stout, punctate, propodus twice as long as broad, with two rows of large tubercles on upper margin, lower margin with a tuberculate carina posteriorly and a smooth carina anteriorly, a smooth carina on upper surface below cutting edge, several large tubercles along cutting edge; dactylus long and stout, punctate, upper margin with two rows of tubercles, cutting edge with one or two large, and several small, tubercles; carpus and merus each with a few scattered small tubercles on upper margin.

Posterior pleurobranch well developed.

Habitat: Magnet Mine, West Coast; Clayton Rivulet (E. Scott); Muddy Creek, Bridport; Wynyard (A. G. Powell).

Engaeus ignotus, sp. nov.

Pl. XIII, figs. 8, 8a, 8b

Length of average adult specimen 75 mm.

Rostrum slender, reaching almost to base of third segment of first antennae, apex rounded, carinae blunt, carried well back on to carapace.

Squame of second antennae short and broad, with a small, sharp spine. Interantennal spine long and slender, bluntly pointed. There is no indication of an exopod on the third maxillipedes.

Sternal keel obsolete between great chelae and second pereopods, bluntly rounded between second and third pereopods. First two pairs of lateral processes obsolete; processes between second pereopods small, bluntly rounded, each with a small, round opening; processes between third pereopods flattened, deeply grooved in centre, each with a conspicuous, irregularly rounded opening on outer margin of upper surface; processes between fourth pereopods long and slender.

Telson narrowly cone-shaped, shorter than uropods, with a spine on lateral margins; inner rami of uropods rounded, divided by a longitudinal median carina, tapering away at posterior margin;

outer rami rounded, divided by a longitudinal median carina, ending in a sharp spine on transverse suture, the transverse suture placed at the posterior third of uropod, several small sharp spines along the suture.

Great chelae short and stout, punctate; propodus one and three-fifths as long as broad, with two rows of tubercles on upper margin, lower margin with a tuberculate carina posteriorly and a smooth carina anteriorly, a smooth carina on upper surface below cutting edge, a few large tubercles along cutting edge; dactylus very short and stout, punctate and minutely tuberculate, upper margin with two feeble carina, feebly tuberculate, cutting edge with one large, and a few small, tubercles; carpus and merus each with numerous small tubercles along upper margin.

Posterior pleurobranch well developed.

Habitat: Smithton (R. H. Champion).

Types in the National Museum, Melbourne.

This species somewhat resembles *E. fossor* Er., but may be distinguished at once by the form of the rostrum, the interantennal spine, and the sternal keel.

Genus **Parastacoides** Clark

Parastacoides Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 48.

Carapace as high as broad, minutely tuberculate. Cervical groove deeply impressed, rounded. Rostral carinae smooth. Abdomen without spines, lateral margins rounded. First segment with lateral lobes large and rounded. Stems of podobranchs without wing-like expansions. No pleurobranchs present. Posterior arthrobranchs rudimentary. Gill formula 12 + 5r + ep.r.

Parastacoides tasmanicus (Erichson)

Pl. XIII, figs. 9, 9a, 9b

Astacus **(*Astacus*)** ***tasmanicus*** Erichson, *Arch. f. Naturg.*, xii., 1846, p. 94.

Astacus tasmanicus Er., White, *List Crust. Brit. Mus.*, 1847, p. 72; von Martens, *Monats. Akad. Wiss. Berlin*, 1868, p. 618.

Astacopsis tasmanicus Er., Haswell, *Cat. Austrl. Mus. Crust.*, 1882, p. 178; Ortmann, *Proc. Amer. Phil. Soc.*, xli., 1902, p. 292; Faxon, *Mem. Mus. Comp. Zool.*, xl., 8, 1914, p. 402 (*Incertae sedis*).

Parastacoides tasmanicus Er., Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 48, pl. vii., fig. 30.

The rostrum is broad, the carinae sharp, and carried well back on to the carapace; the lateral carinae are blunt. The interantennal spine is long and slender. The uropods and telson all have the posterior margin rounded.

Habitat: Lake Margaret; Mt. Lyell (R. Murray); Strahan; Queenstown.

Parastacoides inermis, sp. nov.

Pl. XIII, figs. 10, 10a, 10b

Length of largest specimen 50 mm.

Rostrum broad posteriorly, slender anteriorly, reaching to base of second segment of first antennae, apex sharply rounded; carinae sharp, carried well back on to the carapace, lateral carinae blunt.

Eyes large. Squame broad, sharply pointed, reaching beyond base of third segment of first antennae. Interantennal spine long and stout. Exopods of third maxillipedes reaching to anterior margin of ischius.

Telson broadly rounded, with a spine on each lateral margin at posterior margin. Uropods longer than telson, inner rami each divided by a longitudinal median carina produced to a long, sharp spine beyond posterior margin, posterior margin without other spines, a sharp spine half-way along outer lateral margin; outer rami each with several sharp spines along the transverse suture, upper portion of each ramus divided by two parallel longitudinal median carinae, inner carina continued across posterior portion, ending in a long, sharp spine beyond posterior margin. Telson and uropods densely, minutely tuberculate.

Sternal keel slender and sharp between second and third pereopods; first two pairs of lateral processes slender and sharp, third pair deeply grooved, slender and sharp, fourth pair deeply grooved, sharp; processes between fourth pereopods short and stout. Below lateral processes of third pereopods is a pair of large, round openings.

Great chelae stout, propodus twice as long as broad, densely tuberculate; upper margin serrated, lower margin formed by two rows of tubercles, cutting edge with one large and two or three small tubercles; dactylus stout, densely punctate, setose, cutting edge with several small tubercles, upper margin feebly tuberculate. Carpus with a row of tubercles on upper margin, and numerous small tubercles and punctures on upper surface; merus punctate, upper margin serrated.

Habitat: Adamson's Peak.

Type in the National Museum, Melbourne.

Near *P. tasmanicus* Er. in general appearance of the carapace and chelae, but readily separated by the pointed uropods.

Parastacoides insignis, sp. nov.

Pl. XIII, figs. 11, 11a, 11b

Length of adult specimens 75 mm.

Rostrum broad, reaching to base of third segment of first antennae, apex blunt; carinae sharp, carried well back on to carapace, lateral carinae obsolete.

Eyes large. Squame broad, sharply pointed, reaching to base of third segment of second antennae. Interantennal spine long and very slender. Exopods of third maxillipedes reaching to anterior margin of ischius.

Telson broadly rounded, with a spine on each lateral margin, at posterior margin. Uropods pointed, longer than telson, inner rami each divided by a longitudinal median carina, produced to a long, sharp spine beyond posterior margin, several long, sharp spines along inner half of posterior margin, a spine at apical third of outer margin; outer rami each with several sharp spines along the transverse suture, upper portion of each ramus divided by two parallel longitudinal median carinae, inner carina continued across posterior portion, ending in a long, sharp spine beyond posterior margin. Telson and uropods densely, minutely tuberculate.

Sternal keel very broad between second and third percopods, irregularly rounded, first two pairs of lateral processes small, slender, and sharp; third pair larger, sharp; fourth pair flattened downwards, upper margins sharp. Processes between fourth pereopods short and stout. Below lateral processes of third pereopods is a pair of large, round openings.

Great chelae stout; propodus twice as long as broad, densely tuberculate, upper margin serrated, lower margin formed by two rows of tubercles, cutting edge with one large, and two or three small, tubercles; dactylus stout, densely punctate, setose, cutting edge sharp or with a few feeble tubercles, upper margin feebly tuberculate, a smooth carina on upper surface near upper margin. Carpus with a row of tubercles on upper margin, and numerous small tubercles on upper surface, upper surface punctate; merus punctate, upper margin serrated.

Habitat: Melaleuca Creek, S.W. Tasmania. Collected by Mr. C. King, and presented to the National Museum by Mr. Consett Davis.

Types in the National Museum, Melbourne.

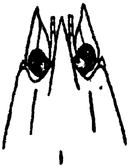
Collected in the button-grass *(Gymnoschoenus sphaerocephalus)* swamps, between New Harbour (near the west end of the south coast of Tasmania) and the head of Melaleuca Creek, which flows into Port Davey.

Although somewhat resembling *P. inermis*, sp. nov., this species may be separated at once by the absence of the lateral carinae of the rostrum, the form of the sternal keel, and the uropods. The spines on the posterior border of the inner rami vary considerably in number in the series examined, but all have at least three very conspicuous spines.

PLATE XII

Head; *a*, interantennal spine; *b*, great chela.

FIG. 1.—*Geocharax gracilis* Clark.
FIG. 2.—*Astacopis franklinii* (Gray).
FIG. 3.—*Astacopsis gouldi* Clark.
FIG. 4.—*Astacopsis tricornis* Clark.
FIG. 5.—*Engaeus cunicularius* Erichson.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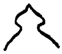
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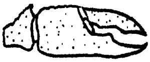
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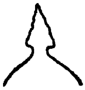
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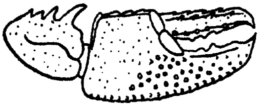
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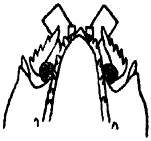
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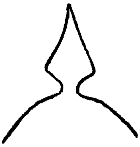
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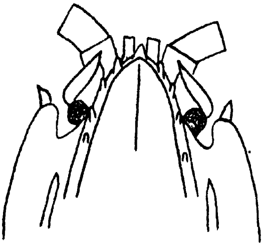
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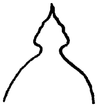
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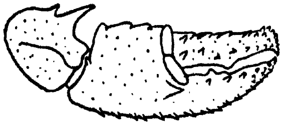
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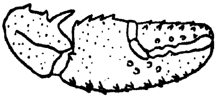
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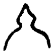
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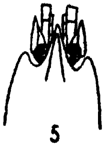
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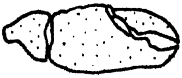
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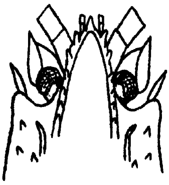
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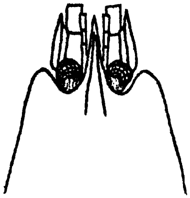
E.C.

PLATE XIII

FIG. 6.—*Engaeus leptorhynchus*, sp. nov.
FIG. 7.—*Engaeus fossor* Erichson.
FIG. 8.—*Engaeus ignotus*, sp. nov.
FIG. 9.—*Parastacoides tasmanicus* (Erichson).
FIG. 10.—*Parastacoides inermis*, sp. nov.
FIG. 11.—*Parastacoides insignis*, sp. nov.

PLATE XIII



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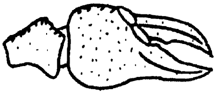

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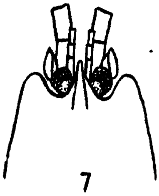

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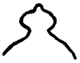

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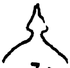

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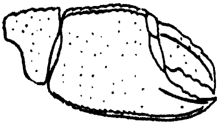

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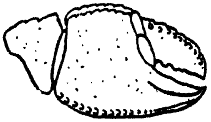

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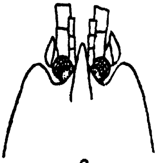

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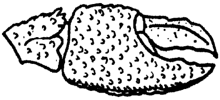

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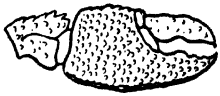
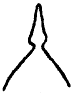


10b



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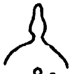

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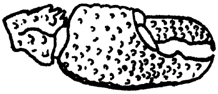

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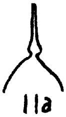

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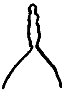

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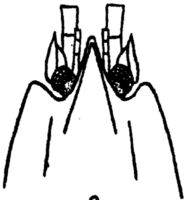

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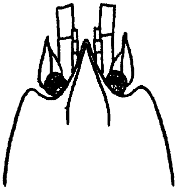

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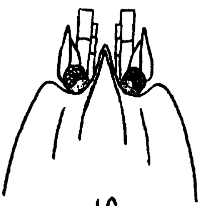

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E.C.

PAP. & PROC. ROY. SOC. TASMANIA, 1938 (14th April, 1939)

The Description of a New Eucalypt Species

By

R. G. BRETT, B.Sc.

(Read 14 November, 1938)

PLATES XIV-XV

Eucalyptus Morrisbyi, sp. nov.

Arbor parva vel media 6-12 m. *alta, cortice levi deciduo, cano v. puniceo, nonnumquam aspero ad imum. Folia juvenilia bina opposita, per multis paribus, glauca, cordata v. cordato-orbicula sessilia,* 2 cm. *longa,* 2·3 cm. *lata. Folia intermedia semi-glauca elliptica vel oblongo-elliptica, alterna, petiolata,* 7·5 cm. *longa,* 3·5 cm. *lata. Folia matura lanceolata vel sub-falcato-lanceolata, alterna,* 8-10 cm. *longa,* 2·5 cm. *lata. Umbellae axillares* 3*—flora, pedunculis compressis v. sub-compressis,* 9-12 mm. *longi. Gemmae maturae glaucae, obconiculae,* 9 mm. *longae,* 7 mm. *latae, pedicellatae. Operculum plano-hemisphaericum, apiculatum, brevius tubo calycino. Fructus glaucus, sub-cylindricus v. sub-urceolatus, sub-costatus,* 8 mm. *longus,* 8·5 mm. *latus. Valvae inclusae.*

A small to medium glaucous tree, with pruinose branchlets, 6-12 m. high. Bark grey to pink, smooth deciduous, sometimes rough at the base. Juvenile leaves opposite for an indefinite number of pairs, glaucous, cordate, crenulate, sessile, and slightly amplexicaul, 2 x 2·5 cm., or larger. Intermediate leaves sub-glaucous, elliptical to oblong-elliptical, 7·5 x 3·5 cm., or larger. Some trees, although mature, do not pass out of intermediate foliage. As in the case of *E. subcrenulata* Maiden and Blakely, this is probably determined by edaphic conditions. Thus the reduced alpine forms of *E. subcrenulata* rarely develop adult foliage. Mature leaves alternate, lanceolate to sub-falcate lanceolate, undulate, sub-glaucous, petiolate, 8-10 cm. x 2·5 cm., petioles 2·5 cm., or longer. Umbels axillary, three-flowered. Peduncles compressed to sub-terete, 9-12 mm. Mature buds obconical, glaucous, pedicellate, the central pedicel developed more than the laterals, 9 x 7 mm. Operculum apiculate to subumbonate, depressed hemispherical, shorter than the sub-costate calyx tube. Fruit pedicellate, depressed cylindrical to sub-urceolate, glaucous, sub-costate, 9 x 8·5 mm. Valves enclosed, tips sometimes slightly protruding.

Habitat: Confined to coastal levels, and thrives on poor, sandy soil.

Distribution: As far as can be judged at present this species is almost extinct. It is confined to a thin belt of trees skirting the beach at the junction of the South Arm and Clifton Beach roads, S.E. Tasmania. An avenue of *E. Morrisbyi*, containing an interesting hybrid with *E. viminalis*, was planted about 50 years ago by Mr. J. R. Morrisby on 'Waterloo', the property of Mr. A. Morrisby. Messrs. A. and M. Morrisby assert that the species formed a dense scrub of at least 50 acres in extent before clearing was undertaken. The rareness of the species resembles that of *E. cordata* Labill.

Genetic Character: E. Morrisbyi is a simple species constituting a single biotype. (Brett, 1938, p. 77.)

Affinities: With *E. cordata* Labill., *E. divaricata* McAulay and Brett, and *E. urnigera* Hook., f.

Hybrids: With *E. viminalis* Labill. The trees retain the general appearance of *E. viminalis*, but fruit and buds are sub-glaucous to glaucous, with valves partially sunk. The buds resemble those of *E. viminalis*, but are somewhat diamond shaped.

Economic Value: The principal economic value of this species is its power to flourish on sandy, coastal soils, where it forms an excellent windbreak. For this purpose it should be planted extensively in Tasmania and on the mainland.

The timber, although not highly recommended for fencing, is reported to make excellent fuel, and should be planted on properties at sea level where timber for firewood is scarce.

The graceful habit and glaucous character suggest suitability for ornamental culture.

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BRETT, R. G., 1938.—A Survey of Eucalyptus species in Tasmania. *Pap. Roy. Soc. Tasm.*, 1937 (1938), pp. 75-109.

PLATE XIV

A.—Intermediate leaves. B.—Adult leaf.

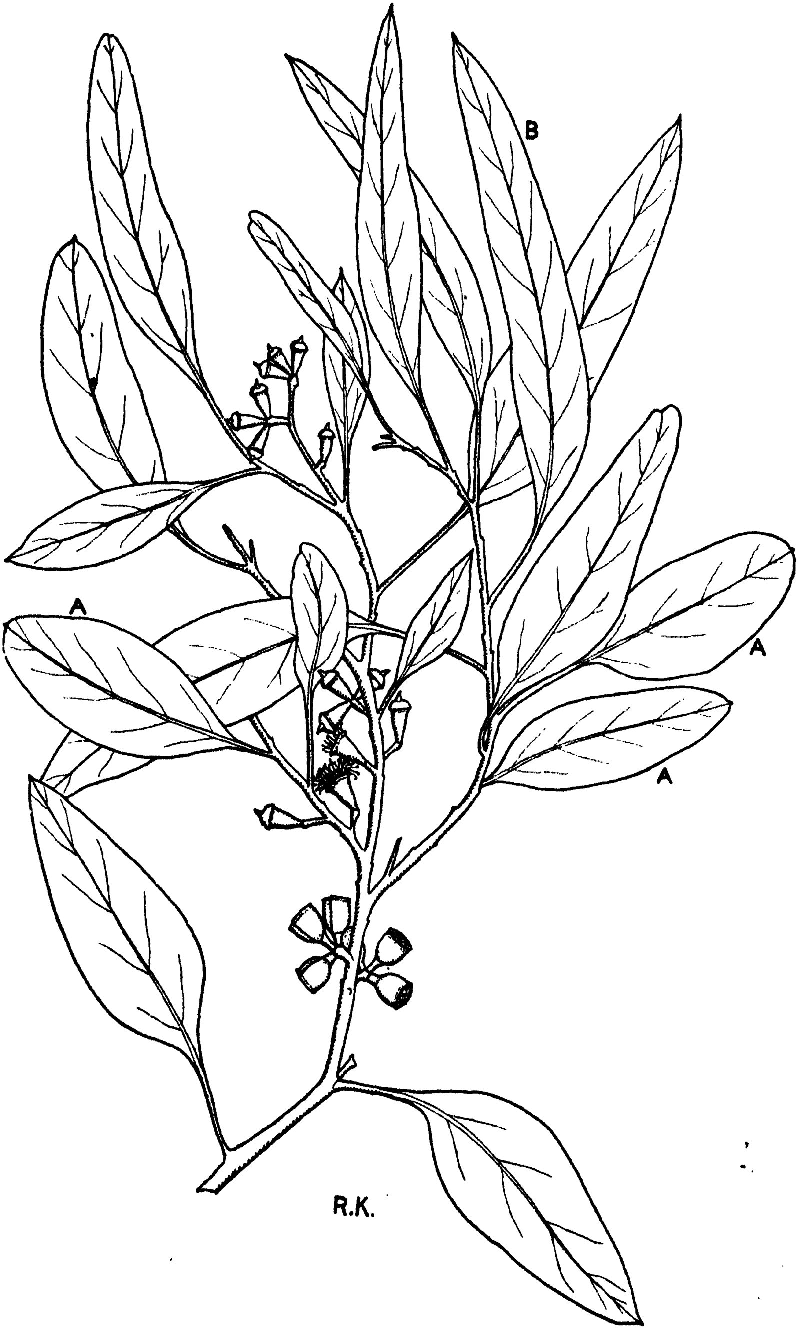
B
A
A
A
R.K.

PLATE XV

FIG. 1.—Sucker foliage showing quadrangular stems.

FIG. 2.—Juvenile foliage of twelve months old seedling, raised from seed collected from tree selected as type.

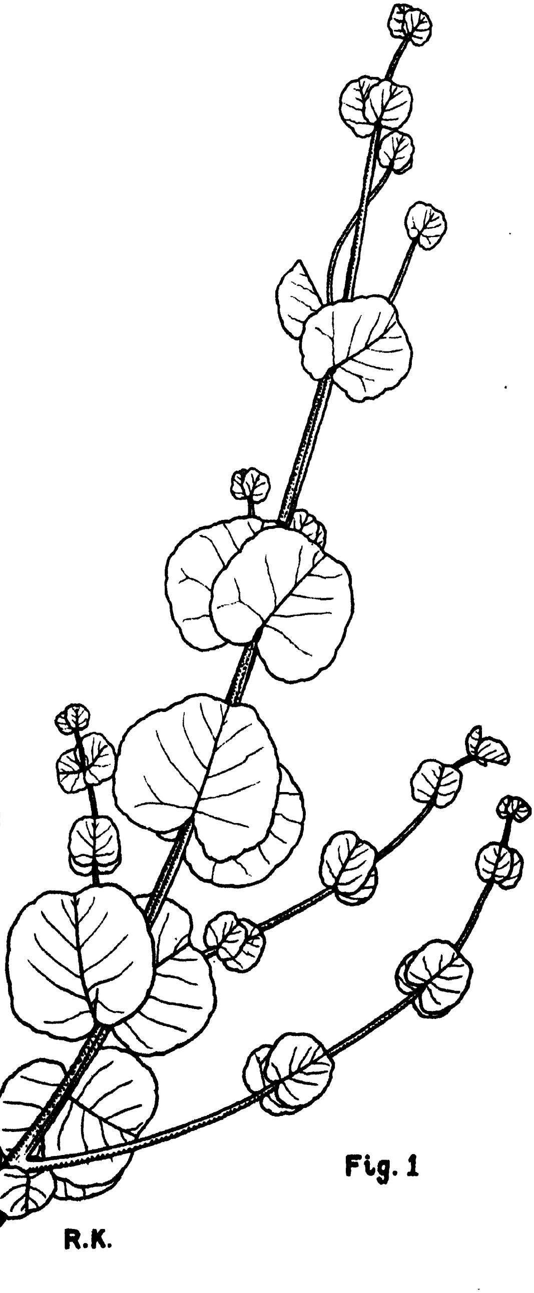

Fig. 1

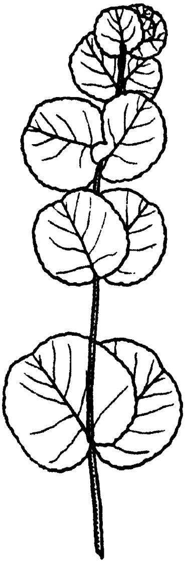

Fig. 2

PAP. & PROC. ROY. SOC. TASMANIA, 1938 (14th April, 1939)

Production of Saltants of *Chaetomium globosum* by Monochromatic Ultra-Violet Irradiation

By

A. L. MCAULAY

(Read 14 November, 1938)

PLATE XVI

Experiments have been made on the production of mutations by irradiation with monochromatic ultra violet light. The basic object of the experiments was to see whether thresholds exist in this phenomenon of the type familiar in photo-chemical reactions. If such thresholds can be demonstrated, a technique of analysis of biological material might be opened up similar to that used by the physicist in his investigation of atomic nuclei, atoms, and molecules.

Three classes of biological material have been tentatively tried: (i) maize pollen, (ii) *Drosophila* larvae, (iii) spores of the fungus *Chaetomium globosum*—

(i) The work on maize has been given up, as the results have been less encouraging than (ii) and (iii).

(ii) Results of interest have been obtained with *Drosophila* by M. C. Taylor, working in this laboratory. The work is technically difficult, and progress must necessarily be slow.

(iii) A preliminary set of experiments has been completed, in which the spores of *Chaetomium globosum* have been irradiated, and results encouraging from the view-point of the main problem have been obtained.

A stage has now been reached where it appears that the most profitable course is to start afresh, using improved methods suggested by the preliminary experiments. The purpose of the present note is to record a few results of interest that have been obtained during the past year. *Chaetomium* was chosen for investigation because of the work of Dickson (1932, 1933) on irradiation by X-rays and heterogeneous ultra violet light of *C. cochliodes* and other species. *C. globosum*, according to Dickson's results, is the least suitable species, but was used as I was able to obtain it in Australia owing to the kindness of Dr. Waterhouse of the Agricultural Department, University of Sydney, who presented me with a culture.

APPARATUS AND METHODS

A monochromator was constructed in this laboratory, of the general type described by Bowden and Snow (1934), using fused quartz lenses and prisms supplied by Messrs. Sharland, of Thavies Inn, London. The diameter of the lenses is 10 cm., their focal length of the order of 15 cm., and the side of the prisms 8 cm. Most of the work has been done using a mercury vapour arc lamp, but condensed sparks have also been used. Intensities have been measured with a Hilger thermopile.

Spores were spread on uranium glass and irradiated in the focussed spectrum. Intensities available by this method are high, and doses up to 3000 joules per sq. cm. have been given with the 365 $m\mu$ mercury line. The irradiated spores were picked up on a brush and transferred to malt agar in a petri dish. The number of spores in a colony separated in this way was very variable, but was to some extent under control. In the experiments to be described it averaged about 50.

Using the above methods, contamination of the spectral line by scattered radiation was serious, and for this reason the early experiments are not here considered. Later, filters were used with the monochromator, and the results should be trustworthy up to a point, though contamination of 313 $m\mu$ by 302 $m\mu$ and of 334 $m\mu$ by 313 $m\mu$ may still have taken place.

SCOPE OF EXPERIMENTS AND GENERAL RESULTS

Experiments were made with wave-lengths 365 $m\mu$, 334 $m\mu$, 313 $m\mu$, 280 $m\mu$, 265 $m\mu$, 254 $m\mu$, and 230 $m\mu$, but most of the irradiation was given with 254 $m\mu$, 313 $m\mu$, 334 $m\mu$, and 365 $m\mu$. Table I indicates the scope of the experiments. Only those saltants have been included which were successfully separated in an apparently pure state, and remained constant in character for at least five or six sub-cultures.

TABLE I

	Wave-length. mμ	No. of Colonies Surviving.	No. of Saltants Separated.	Saltants % of Colonies. %	Average Dose Joules/cm.²
A	254	224	16	7	1·7
	313	163	13	8	143
	334	176	4	2	26·8
	365	239	3	1	515
B	365	180	1	½	2800
Control		396	1	¼	—

It will be noticed in Table IA that the number of saltants produced by 334 mμ and by 365 mμ is very much smaller than by 254 mμ and 313 mμ The reason for this is quite different in the two cases. Owing to difficulties in irradiating with 334 mμ, the average dose given was much below the optimum, and the corresponding production of saltants was low. This was not the case with 365 mu. and it was suspected that the three saltants that appeared might be due to contamination by scattered radiation, owing to the very long exposures necessary. B shows the result of an experiment made under more stringent conditions to check this point. The irradiation was here carried to a point where about two-thirds of the spores were killed, and the fact that only one saltant appeared from 180 colonies suggests that 365 mμ kills before it produces saltants. Continuous irradiation for more than a week was necessary.

The one saltant that appeared in control came at the end of the series of experiments, and contributed to the decision to terminate them and start afresh with new material.

ENERGY REQUIRED TO PRODUCE SALTANTS AT DIFFERENT WAVE-LENGTHS

Saltants are produced over a large range of dosage, and there appears to be an optimum value for the number of saltants produced per colony surviving. Doses very near the lethal probably are less effective under the conditions of these experiments than something less than this. An estimate of this optimum from the present experiments may easily be in error by a factor of 2, but, owing to the very large variations of sensitivity at different wave-lengths, it is still of considerable interest.

Table II shows the orders of magnitude of the doses required to produce saltants.

TABLE II

Wave-length. mμ	*Order of Magnitude of Optimum Dose Joules/cm.*^{2}
230	2
254	2
265	2
313	200
334	200
365	2000

Certain points of interest are apparent. All the doses are very large compared with those required to produce other biological effects, which have been measured in this laboratory. They are, for example, at corresponding wave-lengths over 100 times as great as M. C. Taylor has found to be lethal to *Drosophila* larvae, and I have found to be lethal to *Bacillus coli.*

The effectiveness of wave-lengths between 230 mμ and 265 mμ is of the same order of magnitude, but at 313 mμ about 100 times the dose is needed for the same effect. There is no evidence that 334 mμ is less effective than 313 mμ, but at 365 mμ very few or no saltants are produced, even with doses ten times as great. It should be noticed that if the insensitivity of this material to irradiation is due to anything in the nature of an impenetrable coat the great difference between the short and long doses would be still greater. There is suggestion of discontinuous increases in efficiency in producing saltants as the wave-length is decreased.

Rough measurements indicate that practically all the radiation falling on a spore is absorbed by it, even at wave-lengths as long as 365 mμ. This leads to the conclusion that at 313 mμ a region of the order of volume of an atom (say, 3 x 10^{-23} ccs.) absorbs on an average 20 quanta during the delivery of the optimum dose. Even allowing for four saltants out of five to be missed in the subsequent separation, this absorption produces less than one saltant for 100 spores irradiated. The consequences of this inefficiency are suggestive. If it is due to strong absorption in a sheath external to the sensitive region responsible for the production of a saltant, as pointed out above, the difference between the effectiveness of short and long waves must be even greater than the hundred to one given directly by experiment. If there is no protecting sheath, many quantum hits must be made within every atom of the sensitive region before one is effective in producing a saltant.

THE SELECTIVE PRODUCTION OF SALTANTS

In an attack on the main problem, the first effect to be looked for is a selective production of saltants. One might expect greater homogeneity among the saltants produced by long wave-lengths than among those produced by short. The results obtained show that the phenomenon is very complicated, and it is not claimed that a decisive result has been achieved, but the evidence suggests rather strongly that saltants are produced selectively at different frequencies.

The saltant St. II (fig. 1) is very different from the parent. The following may be taken as criteria by which it may be specified. It is sterile under the standard experimental conditions employed. The aerial mycelium is very sparse. The substratum is dark brown, and dark-red hyphae can easily be seen veining the medium, while the parent hyphae cannot be seen in the medium. The growth of the saltant is slower than that of the parent. It forms a dense leathery skin on the surface of the medium with a tendency to wrinkle.

Plate XVI, fig. 1, shows two photographs of the saltant, eight days old, taken by reflected and transmitted light, and comparison photographs of the normal fungus, eight days old, and of *C. murorum*, 13 days old. In many respects St. II resembles *C. murorum* more closely than its parent. *C. murorum* is sterile in the standard experimental conditions.

Table III records the appearance of St. II among the experiments under consideration, also the diversity of types at three different wave-lengths.

TABLE III

Wave-length.	*Total Number of Saltants.*	*Number of Definitely Distinct Types.*	*Number of Occurrences of St. II.*
254	18	13	1
313	13	7	4
334	4	2	3

In view of the small numbers involved, perhaps the fairest way to present the results is to regard the irradiations as grouped into two classes, 'long' 334 $m\mu$ and 313 $m\mu$, and 'short', 254 $m\mu$. St. II appears seven times out of 17 among the long, and once only, and this a doubtful one, out of 18 among the short wave-lengths. The indications are not, of course, that St. II is produced more freely by the long wave-lengths (the doses given are 100 times as great in this region), but that a larger variety of saltants are produced by the short wave-lengths. This is borne out to some extent by the fact that 13 out of 18 of the short-wave saltants are distinct from one another, while only eight out of 17 of the long-wave saltants are of different types.

GENERAL NATURE OF SALTANTS

The following are some of the principal characters that have been observed in the saltants produced in this work.

Saltants are produced with very dense aerial mycelium. In one class this lies close to the medium, giving a matte appearance like filter-paper. In another it is deep as well as dense, completely hiding everything beneath it. The paper-like mycelium may be white or pink, the deep mycelium white or yellow. Both paper-like and deep mycelium may be sterile or carry fertile perithecia. In some saltants the perithecia form on top of the dense, deep aerial mycelium, in some what look like small sterile perithecia without hairs form beneath the surface of the medium. Two saltants form sclerotia. Another shows marked zones, the zoning character appearing in all the progeny, whether grown from mycelium or spores. Perithecia may be yellow-white, blue turning black, or black. All these are fertile, and the spores breed true. There are varying types of infertile perithecia, ranging from bodies looking very like the fertile parent perithecia to small, round translucent bags without hairs. The growth rate varies in different saltants, and may be the same, greater, or less than that of the parent. Plate XVI, fig. 2, shows photographs of a few selected saltants.

IRRADIATION OF SALTANTS AND REPRODUCTION OF THE PARENT FROM A SALTANT

Spores from two of the saltants have been irradiated. Though these saltants were apparently quite stable normally, they both saltated freely when irradiated. This work has not yet been followed up, and only one or two of the secondary saltants have been separated in an apparently pure state. One was apparently identical with the parent (Plate XVI, fig. 3), and has remained so through several sub-cultures. This is in agreement with a similar result observed by Dickson (1932) with *C. cochliodes*, using X-rays. It is, of course, of particular interest as showing that the action of the radiation cannot be looked on as merely destructive. The reproduction of the parent form from the saltant was, in this case, brought about by a wave-length of 230 $m\mu$.

SUMMARY

The following are the most important new facts recorded:—

(i) The optimum dose of ultra violet radiation for the production of saltants in *C. globosum* is of the following order—

Short wave-lengths, 230 $m\mu$ to 265 $m\mu$, 2 x 10^7 ergs/cm^2.

313 $m\mu$, and probably 334 $m\mu$, 200 x 10^7 ergs/cm.^{2}

365 $m\mu$, if effective at all, 2000 x 10^7 ergs/cm.^{2}

(ii) The effectiveness of ultra violet radiation in producing saltants in *C. globosum* is very small (or perhaps zero) at wave-lengths as long as 365 $m\mu$. The ratio saltant-producing effect to lethal effect is smaller than for shorter wave-lengths.

(iii) A saltant produced by irradiation, which was quite stable under normal conditions, saltated freely on irradiation and, among other things, reproduced the parent strain.

In addition to the above facts, it is shown that there is evidence that suggests that saltants are produced selectively by different wavelengths. This is an aspect of the primary object of the investigation, and a fresh series of experiments is planned to follow it up.

The funds required for the above work came from the Commonwealth Research Grant to the University. I wish to thank the trustees of the Science and Industry Endowment Fund for a grant for apparatus made me in 1936, and Dr. W. L. Waterhouse, of the Department of Agriculture, University of Sydney, who very kindly supplied the culture of *Chaetomium globosum*, which has provided the material for these experiments.

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DICKSON, H., 1933.—Saltations induced by X-rays in Seven Species of *Chaetomium*. *Annals Bot.* 47. pp. 735-754.

BOWDEN AND SNOW, 1934.—Physico-chemical Studies of Complex Organic *Molecules*. Part I.: Monochromatic Irradiation. P.R.S. (B) 115. pp. 262-273.

PLATE XVI

FIG. 1:

a. Four colonies of normal *C. globosum*, 8 days old, reflected and transmitted light. × ⅓.

b. Four colonies of St. II. Four separate saltants produced by 313 mμ, 8 days old, reflected and transmitted light. × ⅓.

c. Four colonies of *C. murorum*, 13 days old. × ⅓.

FIG. 2.—Typical saltants produced by irradiation:

a. Produced by 254 mμ, 8 days old. Bottom, zoning fungus, produces sparse fertile perithecia after about a month. × ⅓.

b. Four saltants produced by 313 mμ, 8 days old. Bottom, fungus bears black perithecia on top of dense, deep, dirty-white mycelium. × ⅓.

c. Saltant, produced by 254 mμ, showing knots of sclerotia. It periodically produces dense, white, barren mycelium (see top right). These characters are reproduced in sub-cultures. × ⅓.

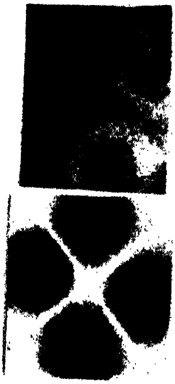
d. Two slow-growing saltants produced by 254 mμ, 17 days old. Both bear barren perithecia. The branching fern-like mycelium of the top one can be seen under the surface of the medium × ⅓.

e. Very slow growing dense saltant which wrinkles surface of medium, 8 days old. Compare 1*a* normal fungus of same age. × ⅓.

f. Photograph of perithecia on an older culture of e. The saltant comes true from spore or mycelium subcultures. Natural size.

FIG. 3.—The saltant which on irradiation reverted to the parent form. The reversion is in the middle, flanked on either side by colonies of the saltant from which it arose. Natural size.

PLATE XVI



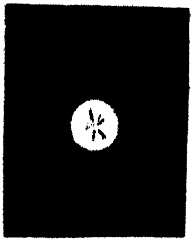
1a

1b

1c

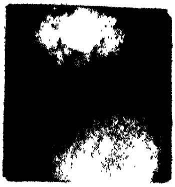
2a

2c



2e

2b



2d

2f

3

PAP. & PROC. ROY. SOC. TASMANIA, 1938 (24TH MAY, 1939)

Observations on Some Tasmanian Fishes.

Part IV

By

E. O. G. SCOTT, B.SC.

(Read 14th November, 1938)

The present paper, the precise scope of which is summarized in the concluding paragraph, follows the general plan of previous communications under the same title (1934, 1935b, 1936).

Keys are provided for the families containing the Tasmanian species dealt with in the present paper. It is hoped that these keys may also help in the identification of species hitherto not recorded from Tasmania.

Registration numbers are those of the Queen Victoria Museum, Launceston.

Family SYNGNATHIDAE

In the Australian Check-List (McCulloch, 1929) only seven members of the family, representing six genera, are accredited to Tasmania, namely: (*a*) *Leptonotus semistriatus* Kaup, 1856; (*b*) *Histiogamphelus briggsii* McCulloch, 1914; (*c*) *Stigmatopora argus* (Richardson, 1840); (*d*) *S.nigra* Kaup, 1856; (*e*) *Solegnathus spinosissimus* (Günther, 1870); (*f*) *Phyllopteryx foliatus* (Shaw, 1804); (*g*) *Hippocampus (Maclcayina) abdominalis* Lesson, 1827: in the case of (*b*), (*c*), (*d*) Tasmania affords the type-locality. To these may be added the following species: (*h*) *Corythoichthys phillipi* (Lucas, 1891); (*i*) *Urocampus carinirostris* Castelnau, 1872; (*j*) *Leptoichthys fistularius* Kaup, 1853; (*k*) *Solegnathus fasciatus* (Günther, 1880); (*l*) *S.robustus* McCulloch, 1911; (*m*) *Hippocampus breviceps* Peters: of these (*h*), (*j*), (*k*), (*l*), (*m*) are discussed in the present series of papers; (*i*) is recorded by Lord and Scott (1924).

A key to the Tasmanian Syngnathidae, and to most of the species recorded from Victoria and South Australia, (1) is appended.

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(1) Species recorded from Victoria not incorporated in key are *Hippocampus tristis* Castelnau, 1872, *H.bleekeri* Fowler, 1908, *H.agnesae* Fowler, 1908; from South Australia, *Syngnathus pelagicus* Linné, 1758.

KEY TO SYNGNATHIDAE RECORDED FROM TASMANIA: WITH SOME DIAGNOSTIC CHARACTERS [IN SQUARE BRACKETS] OF ALLIED SPECIES OCCURRING IN VICTORIA AND SOUTH AUSTRALIA.

1. Caudal fin present (sometimes rudimentary). Tail not prehensile .... (2)
Caudal fin absent. Tail often prehensile .... (14)

2. Body smooth, without ridges, the angles scarcely defined. Dorsal fin short, borne on 3 annuli; its base $=$ its height. Tail $>$ 4.0 trunk
[D. 11. Annuli $12 + 60$; subdorsal $1 + 2$. Snout 3.1 in head. Eye 2.0 in snout. Head 2.5 in trunk. Trunk 4.8 in tail. Length 100mm. .... *Lissocampus caudalis*]
Body with longitudinal ridges, the angles well-defined. Dorsal fin long, or moderately long, borne on more than 4 annuli; its base $>$ its height. Tail $<$ 4.0 trunk .... (3)

3. Dorsal edges of trunk and tail not continuous .... (4)
Dorsal edges of trunk and tail continuous
[D. 26-27. Annuli $19\text{-}20 + 40\text{-}41$; subdorsal $1\text{-}2 + 5$. Snout with elevated obtuse crest: 4.7 in head. Eye 1.3 in snout. Head 3.6-4.4 in trunk. Length 215mm. .... *Ichthyocampus cristatus*]

4. Dorsal fin far ($>$ length of its base) behind vent
D. 14. Annuli $8\text{-}9 + 43\text{-}53$; subdorsal 7-10 of caudal. Snout 3.0-3.3 in head. Eye 1.8 in snout. Head 1.5-2.5 in trunk. Length 110mm. .... *Urocampus carinirostris*
Dorsal fin over, or near ($<$ length of its base from), vent .... (5)

5. Caudal annuli $>$ 30. Length of caudal fin $<$ distance from anterior border of eye to opercular margin .... (6)
Caudal annuli $<$ 30. Length of caudal fin $>$ (about 2) distance from anterior border of eye to opercular margin
D. 34-38. Annuli $25\text{-}28 + 20\text{-}27$; subdorsal $3\text{-}4 + 5\text{-}6$. Snout 1.4 in head. Eye 7.1 in snout. Head 2.0-2.5 in trunk. Length 360mm. .... *Leptoichthys fistularius*

6. Dorsal crest on snout a conspicuous knife-like ridge, at least ½ as high as tubular portion of snout. Base of dorsal fin elevated above general dorsal profile. Tasmanian species with vent posterior to middle of dorsal fin .... (7)
Dorsal crest on snout small, $<$ ½ as high as tubular portion of snout. Base of dorsal fin not elevated above general dorsal profile. Tasmanian species with vent anterior to middle of dorsal fin .... (8)

7. Vent posterior to middle of dorsal fin. Total annuli $<$ 63. Dorsal fin with 28 rays. Snout subequal to rest of head
D. 23. Annuli $22 + 36$; subdorsal $5 + 2$. Snout 2.1 in head. Eye 2.5 in snout. Head 4.6 in trunk. Length 235mm. *Histiogamphelus briggsii*
Vent anterior to middle of dorsal fin. Total annuli $>$ 63. Dorsal fin with $>$ 28 rays. Snout about 2 rest of head
[D. 32-33. Annuli $25\text{-}26 + 44$; subdorsal $3 + 7$. Snout 1.5 in head. Eye 7.4 in snout. Head 1.9 in trunk. Length 280mm. .... *Histiogamphelus rostratus*]

8. Female with dorsal surface conspicuously elevated, ventral surface acute. Tasmanian species with $>$ 30 dorsal rays .... (9)
Female more or less like male. Tasmanian species with $<$ 30 dorsal rays .... (11)

9. No ridge on opercle. Dorsal fin with >35 rays. Snout > ½ head

[D. 38-40. Annuli 20-21 + 47-49; subdorsal 4-5 + 6-7. Snout 1.6-1.7 in head. Eye 7.2 in snout. Head 1.9 in trunk. Length 235mm. .... *Leptonotus semistriatus*]

Ridge on basal half of opercle. Dorsal fin with < 35 rays. Snout < ½ head .... (10)

10. Vent anterior to middle of dorsal fin. Trunk ½ total length. Subdorsal annuli < 7

[D. 24. Annuli 17 + 42-44; subdorsal 1 + 5. Snout 2.3 in head. Head 4.0-4.5 in trunk. Length 100mm. .... *Leptonotus caretta*]

Vent posterior to middle of dorsal fin. Trunk < ½ total length. Subdorsal annuli > 7

[D. 28-32. Annuli 16-17 + 37-38; subdorsal 5-6 + 3-4. Snout 2.6 in head. Eye 2.5 in snout. Head 2.5 in trunk. Length 120mm. .... *Leptonotus costatus*]

11. Opercle with raised radiating lines, but no median keel. Head > 2.75 in trunk

[D. 20-24. Annuli 18-19 + 42-44; subdorsal 0-1 + 4-5. Snout high. Ventral surface wider than dorsal surface. Snout 2.5-2.7 in head. Eye 1.8 in snout. Head 3.0-3.5 in trunk. Length 160mm. .... *Syngnathus curtirostris*]

Opercle with prominent median keel. Head < 2.75 in trunk .... (12)

12. Snout > 2.3 in head; the latter > 2.3 in trunk. Eye larger; < 6.5 in head, < 3.0 in snout. Upper body ridge continued on to 4th caudal scute

[D. 18-20. Annuli 16-17 + 41-43; subdorsal 0-1 + 4-5. Snout 2.5 in head. Eye 2.5 in snout. Head 2.5 in trunk. Ventral surface of trunk V-shaped and ridged. Length 100mm. *Corythroichthys vercoi*]

Snout < 2.3 in head; the latter < 2.3 in trunk. Eye smaller; > 6.5 in head, > 3.0 in snout. Upper body ridge continued beyond 4th caudal scute .... (13)

13. Head > 1.7 in trunk. Eye < 4.0 in snout. Upper body-ridge continued on to 5th caudal scute

D. 22-28. Annuli 18-20 + 40-48; subdorsal 1-2 + 5-6. Snout 1.9 in head. Eye 3.4 in snout. Head 2.0 in trunk. Length 130mm. .... *Corythroichthys phillipi*

Head < 1.7 in trunk. Eye > 4.0 in snout. Upper body-ridge continued on to 6th caudal scute

[D. 26-29. Annuli 19-20 + 44-49; subdorsal 1-2 + 5-6. Snout 1.75 in head. Eye 4.5 in snout. Head 1.4 in trunk. Length 270mm. .... *Corythroichthys poecilolaemus*]

14. Head, trunk and tail with conspicuous foliaceous appendages. Tail prehensile .... (15)

Without such conspicuous foliaceous appendages. Tail prehensile or not prehensile .... (16)

15. Foliaceous appendages simple. Ventral segmental spines short (one eye-diameter, or less). Snout > 3 postorbital portion of head. Subdorsal annuli > 10

D. 27-36. Annuli 17-18 + 32-37; subdorsal 1-2 + 5-7. Snout 1.4 in head. Eye 7.1 in snout. Head 1.3-1.5 in trunk. Length 390mm .... *Phyllopteryx foliatus*

Foliaceous appendages multifid. Ventral segmental spines long (up to two eye-diameters, or more). Snout < 3 postorbital portion of head. Subdorsal annuli < 10

[D. 35-37. Annuli 18-19 + 36-40; subdorsal 0-1 + 11. Snout 1.6-1.7 in head. Eye 4.8-5.1 in snout. Head 1.3 in trunk. Length 300mm. .... *Phyllopteryx eques*]

16. Trunk broader than deep. Length from eye to origin of dorsal fin $<$ base of dorsal fin. Body-annuli > 15, < 23. Subdorsal annuli $>$ 14. Tail not prehensile ... ... (17)

Trunk deeper than broad. Length from eye to origin of dorsal fin $>$ base of dorsal fin. Body-annuli < 15, or > 23. Subdorsal annuli $<$ 14. Tail prehensile ... ... (18)

17. Vent posterior to middle of dorsal fin. Mediolateral body-ridge extending on to 1st caudal scute (in the greatly expanded female produced to form a sharp edge). Well-developed opercular keel

D. 35-43. Annuli 16-18 + 58-72; subdorsal 10-12 + 6-7. Snout 1.6-1.7 in head. Eye 5.0-6.3 in snout. Head 1.6 in trunk. Length 110mm. ... ... *Stigmatopora nigra*

Vent below, or anterior to, middle of dorsal fin. Mediolateral body-ridge extending on to about 6th caudal scute, or beyond, or terminating in skinny folds of brood-pouch. No opercular keel in adult

D. 43-55. Annuli 17-22 + 68-90; subdorsal 7-10 + 8-12. Snout 1.5 in head. Eye 6.2-7.6 in snout. Head 1.3 in trunk. Length 250mm. ... ... *Stigmatopora argus*

18. Head not noticeably equine, its depth $<$ (about ½) length of snout. Body-annuli > 15. Total annuli > 65 ... ... (19)

Head decidedly equine, its depth $>$ length of snout. Body-annuli < 15. Total annuli < 65 ... ... (21)

19. Trunk about 2.0 head. Depth of snout 6, or more, in its length. Depth of tail immediately behind the dorsal fin, 4, or more, in base of dorsal. Mediolateral ridge attains, or virtually attains, dorsal profile immediately behind termination of dorsal fin ... ... (20)

Trunk about 2.5 head. Depth of snout 5 in its length. Depth of tail immediately behind the dorsal fin about 3 in base of dorsal. Mediolateral ridge attains dorsal profile near, or behind, middle of tail

D. 29-34. Annuli 26-27 + 48-53; subdorsal 0 + 10. Eye 3.9 in snout. Snout 1.7-1.9 in head. Head 2.4-2.7 in trunk. Each trunk-scute with flattened central spine, from which radiate lines of smaller, but well-developed, spines. Length 365mm. ... ... *Solegnathus robustus*

20. Scutes intensely spiny. At middle of either lateral border of each trunk-scute a four- or five-rayed cluster of spines, diverging from an enlarged central spine or small group of spines

D. 35-38. Annuli 27-29 + 51-55; subdorsal 0 + 10. Eye 4.0-5.0 in snout. Snout 1.7 in head. Head 2.0 in trunk. Each trunk-scute with a system of spinigerous ridges in the form of a lozenge, or ellipse, and a vertical ridge running from apex to apex; vertical ridge terminating in a large two- or three-crowned spine forming part of longitudinal body-ridge. Length 320mm. ... ... *Solegnathus spinosissimus*

Scutes mainly rugose. At middle of either lateral border of each trunk-scute a spinigerous fusiform fascia, with an enlarged central spine, or an elliptical boss with elevated centre from which radiate numerous rows of blunt spinules

D. 39-41. Annuli 25-28 + 53-55; subdorsal 0 + 10-12. Eye 4.0-5.0 in snout. Snout 1.7 in head. Head 2.0 in trunk. Each trunk-scute with a system of from about three to six subvertical rather sparsely, often obscurely, spinigerous ridges that through most of their length are subparallel, generally becoming approximated above and below, where they terminate in a large two- or three-crowned spine forming part of longitudinal body-ridge. Length 370mm. ... ... *Solegnathus fasciatus*

21. Axis of head virtually in line with that of trunk, the angle included between ventral cephalic and thoracic profiles much > 90°. Dorsal and ventral profiles of trunk subparallel. Tail without prominent tubercles. Occiput compressed into a crest, without coronet
[D. 15. Annuli 12 + 38; subdorsal 3 + 1. Eye 1.5-1.8 in snout. Snout 2.9-3.2 in head. Head 2.0 in trunk. Length 55mm. .... *Acentronura australis*]

Axis of head markedly oblique to that of trunk, the angle included between ventral cephalic and thoracic profiles (usually much) < 90°. Dorsal and ventral profiles of trunk convex in opposite senses. Tail with prominent tubercles. Occiput compressed into a crest, produced behind to form coronet .... (22)

22. Dorsal rays > 24. Dorsal base on 6, or more, annuli, of which 3, or more, are caudal. Total annuli > 54
D. 26-31. Annuli 11-13 + 44-49; subdorsal 3-5 + 3-5. Eye 2.5 in snout. Snout 2.5 in head. Head 1.7 in trunk. Length 260mm. .... *Hippocampus abdominalis*

Dorsal rays < 24. Dorsal base on fewer than 6 annuli, of which fewer than 3 are caudal. Total annuli < 54 .... (23)

23. Dorsal rays > 18. Snout > 2.5 in head. Eye < 3 in snout. Minimum nuchal depth < half maximum depth of trunk. Total annuli > 48
D. 19-22. Annuli 11 + 38-42; subdorsal 3-4 + 1. Eye 2.1 in snout. Snout 3.0 in head. Head 1.5 in trunk. Length 70mm. .... *Hippocampus breviceps*

Dorsal rays < 18. Snout < 2.5 in head. Eye > 3 in snout. Minimum nuchal depth > half maximum depth of trunk. Total annuli < 48
[D. 16-17. Annuli 11 + 33-36; subdorsal 2-3 + 1. Eye 3.5 in snout. Snout 2.0 in head. Head 1.2 in trunk. Length 160mm. .... *Hippocampus novae-hollandiae*]

Genus **Corythoichthys** Kaup, 1853

Corythoichthys phillipi (Lucas, 1891)

Syngnathus phillipi Lucas, *Proc. Roy. Soc. Vict.* (n.s.) III. 1891. pp. 8 and 12.

Distribution.—To distribution in Check-List (Victoria, South Australia) may be added Western Australia (Waite and Hale, 1921), Tasmania (McCulloch, 1911).

Genus **Leptoichthys** Kaup, 1853

Leptoichthys fistularius Kaup, 1853

Leptoichthys fistularius Kaup, *Arch. Naturg.* XIX. 1. 1853. p. 233: *ex Typhus fistularius* Bibron MS.

Record.—Specimen (Reg. No. 916FR) picked up on beach at Bridport by Miss Betty von Steiglitz, January, 1936. First record for Tasmania.

Remarks.—Although somewhat abraded, and having the greater part of the snout and the tip of the caudal fin missing, the specimen is clearly referable to this species. In its present condition the fish has a total length of 270 mm., to which perhaps 50 mm. would have been added when it was perfect. Annuli 25 + 20, of which 3 + 6 are subdorsal.

Distribution.—To distribution in Check-List (Western Australia, South Australia) may be added Victoria (Waite and Hale, 1921; Mack, 1934), Tasmania.

Genus **Leptonotus** Kaup, 1853

Leptonotus semistriatus Kaup, 1856

(Text fig. 1)

Leptonotus semistriatus Kaup, *Arch. Naturges.* XIX. 1. 1853. p. 233: *nom. nud.* *Id.* Kaup, *Cat. Lophob. Fish. Brit. Mus.* 1856. p. 48.

Syngnathus semifasciatus Günther, *Cat. Fish. Brit. Mus.* VIII. 1870. p. 162: *emend. pro Leptonotus semistriatus* Kaup.

Syngnathus verreauxianus Duméril, *Hist. Nat. Poiss.* II. 1870 p. 573.

Distribution.—To distribution in Check-List (South Australia, Tasmania) may be added Victoria (Mack, 1934). Waite and Hale (1921) exclude this species from the South Australian list, interpreting 'South Australia'—which Günther (1870) stated was written on label of holotype, though Kaup (1856) had stated its origin was not noted—as 'Southern Australia,' and stating they have no records of it from South Australia, where, they believe, its place is taken by *L. costatus* Waite and Hale.

Remarks.—Australian literature available here does not include any recent descriptive account of this species, and no illustration appears to have been published: a redescription and figure, based on a Victorian specimen, are offered below.

Description.—D.38. P.11. C.5. A.5. Annuli 20 + 47; subdorsal annuli 4 + 7.

Head 2.8 in length to vent, 6.4 in length to base of caudal, 6.5 in total length. Eye 6.0 in snout, which is 1.6 in head. Base of dorsal 3.7 in length to its origin. Maximum depth 18.0, depth at opercular margin 33.2, at origin of dorsal 22.7, at vent 32.2, at middle of tail 72.0, in total length.

Smooth, without spines. Head and body compressed, maximum width of latter 2.4 in maximum depth. Tail subquadrangular, its width at vent 1.3 in its depth there, its width at middle 1.1 in its depth there. Seven trunk-ridges, including median ventral keel; all rather small, but well defined: dorsal surface of trunk unridged, gently arched. Superolateral trunk ridge continued to near middle of sixth caudal scute; mediolateral ending in hinder third of last body-scute; posterolateral continuous with that of tail; ventral ending just in advance of vent: superolateral ridge of tail originating near anterior margin of last body-scute, attaining dorsal profile about 11 annuli in advance of origin of caudal.

Snout long and slender, rather more than twice postorbital portion of head; nostril about two-thirds an eye-diameter in advance of orbit. Interorbital space nearly flat, bounded by feeble supraorbital ridges, which converge anteriorly and meet at about level of nostril, and thence proceed forward as an obsolescent median ridge on snout. Superolateral ridge of snout diverging posteriorly, at about an eye-diameter in front of orbit, to enclose subtriangular depression, in which nostril lies; inferolateral extending to about level of hinder orbital margin; medioventral feebly developed near level of eye, in advance of which it rapidly tends to become obsolete. Minute ridge on occiput and nape. Operculum without ridge, but with radiating striae.

Dorsal fin barely encroaching on third annulus in advance of that bearing vent, terminating on anterior half of seventh caudal annulus; base subequal to combined eye and snout; height subequal to eye. Length of pectoral 1.5 times width of its base, or about half postorbital of head. Anal minute. Caudal rounded, its length 5.1 in snout.

Head minutely punctulate, and vermiculately ridged and channelled. Body-scutes with pattern of delicate ridges (not shown in figure). (1) Median row of scutes each with lyrate pattern in lower four-fifths, junctioning with fan of ridges in upper fifth: upper row with fan in lower two-thirds, and less developed fan in upper third: other rows with pattern resembling karyokinetic spindle.

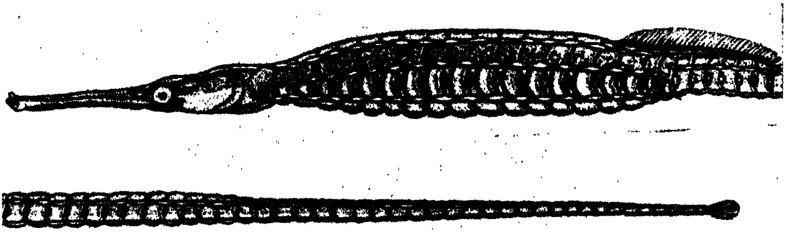

Fig. 1.—*Leptonotus semistriatus* Kaup. Total length 216 mm.
(For convenience in reproduction, this figure has been cut in two. The upper figure shows the anterior half of the fish, and the lower figure shows the posterior half.)

General colour in alcohol greyish yellow, becoming somewhat lighter below; brownish band extending from near middle of snout, across upper half of operculum and along upper lateral row of body-scutes; whitish stripe from eye, across opercle, to base of pectoral; brownish mid-dorsal stripe from about level of nostril to origin of dorsal; upper half of tail darker than lower; scattered whitish ocelli on upper lateral row of body-scutes.

Described and figured (text fig. 1) from a Victorian specimen, 216 mm. in total length, in the collection of the National Museum, Melbourne.

Comparison with Holotype.—Original description is short; but notes six dimensions. Kaup's measurements yield head 6.4, depth 14.0, tail 1.8 in total length; snout 1.7 in head; width of body 3.4 in its depth: these proportions agree well with those noted above, but present specimen has noticeably wider body. One ray fewer in pectoral of present specimen is negligible; but I find only 5 caudal rays, as against 10 noted for holotype. Total annuli agree; but holotype has one fewer trunk, and one more caudal, annulus. The difference in number of subdorsal annuli on trunk is probably a question of mode of counting: formula given above includes the annulus on to which dorsal base barely encroaches; Kaup quite probably adopted the legitimate convention that this minor extension cephalad should be discounted.

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(1) Remarking, regarding this pattern, 'The bands are transverse, (*fasciae*), and not longitudinal (*striae*)', Günther (1870), p. 162, footnote) suggested the emendation of Kaup's specific name *semifasciatus* to *semistriatus*.

Family ARRIPIDAE

Of the two Australian members of the family—*Arripis georgianus* (Cuvier and Valenciennes, 1831), *A. trutta* (Bloch and Schneider, 1801)—the latter only has hitherto been recorded from Tasmania: the former is here noted for the first time from our waters.

KEY TO ARRIPIDAE RECORDED FROM TASMANIA

D. IX, 14.—Body decidedly rough (1): its depth > length of head. Two well-developed opercular spines. Basal portion of scale with fine striations parallel with anterior border, but no longitudinal ridges. (2) Without brassy trout-like spots on side .... *A. georgianus*.

D. IX, 15-17 (usually 16). Body virtually smooth: its depth < length of head. Opercular spines obsolescent. Basal portion of scale with fine striations parallel with anterior border, and with several longitudinal ridges. Specimens up to about 10 inches, or more, in total length with several rows of conspicuous brassy trout-like spots on side .... *A. trutta*.

Genus **ARRIPIS** Jenyns, 1840

Arripis georgianus (Cuvier and Valenciennes, 1831)

Centropristis georgianus Cuvier and Valenciennes, *Hist. Nat. Poiss.* VII. 1831. p. 451.

Arripis georgianus Jenyns, *Zool. Voy. Beagle, Fish.* 1840. p. 14.

Record.—Specimen (Reg. No. 917FR) of total length 251 mm., standard length 196 mm., caught near George Town by Mr. C. Andrews on 18th March, 1937; forwarded to the Museum by Mr. G. R. F. Green. I am informed by Mr. Green that about ten days before half a dozen specimens were included among a consignment sent to the Launceston Fish Market from the Islands Straits. First record for Tasmania.

(1) Hence the vernacular name of *Roughy*, or *Tommy Rough*: also called *Wankaldi*.

(2) Name of genus based on absence in genotype of the customary fan-system of ridges on basal portion of scale. In *A. trutta*, however, there is a suggestion of the fan in the shape of three or four subparallel ridges.

Remarks.—From a consideration of the known habits and geographical range of the genotype, I have long thought it probable the present species visits, upon occasion, the northern waters of Tasmania: it is now some years since I first requested various observers to keep a sharp lookout for this species, and it is an interesting and pleasing circumstance that Mr. Andrew's keenness has resulted in its addition to the Tasmanian list.

Arripis trutta (Bloch and Schneider, 1801)

Sciena trutta Bloch and Schneider, *Syst. Ichth.* 1801, p. 542: *ex* Forster MS.

Arripis trutta McCulloch, *Mem. Aust. Mus. Sydney.* V. II. 1929. p. 200 (references and synonymy).

Remarks.—Known from New Zealand, Lord Howe Island, Norfolk and Raoul Islands, and from all the Australian States, first record for Queensland being noted recently by Whitley (1937, p. 135).

One of the commonest fishes in Launceston shops: great majority of individuals 200-300 mm. in total length; but examples reaching a length of about 500 mm. are not rare.

Vernacular names, as given in the books, include; Salmon; Salmon Arripis (McCoy, 1878); Australian, Native, or Colonial Salmon; Sydney Salmon (Stead, 1906); Kahawai (Phillipps, 1927); Salmon Trout (young); Newfish (young) (Stead, 1906). In Launceston fish-shops this species is usually sold under the name of Salmon, Blackback Salmon, Cocky Salmon (*Cocky*, an Australian farmer), Cock-Eye or Cock-Eyed Salmon (presumably a corruption resulting from misapprehension of preceding name), or Salmon Trout (young).

It is of interest to note that in July, 1934, there was received at the Museum a specimen of *Squilla sp.*, 110 mm. long, taken intact from the stomach of a specimen of *Arripis trutta* caught near George Town, Northern Tasmania.

Family BLENNIIDAE, *sensu lato*

Like many of our small fishes the Tasmanian Blennies are much in need of revision: while it is at present impracticable to solve all problems presented by the group, it is hoped the present observations may at least to some extent clear the ground for future progress.

The members of the family Blenniidae, *sensu lato*, including those forms segregated by many modern authors as belonging to the family Clinidae, accredited to Tasmania in the Australian Check-List (McCulloch, 1929) number seven species: (*a*) *Blennius tasmanianus* Richardson, 1839; (*b*) *Gillias clarkei* (Morton, 1888); (*c*) *Clinus perspicillatus* Cuvier and Valenciennes, 1836; (*d*) *Clinus johnstoni* Saville Kent, 1886; (*e*) *Petraites incertus* McCulloch, 1915; (*f*) *Cristiceps australis* Cuvier and Valenciennes, 1836; (*g*) *Cristiceps forsteri* Castelnau, 1872. One other species described from Tasmania, *Clinus despicillatus* Richardson, 1839 (type-locality Port Arthur, Southern Tasmania), has long been regarded as an undoubted synonym of *C. perspicillatus,* and calls for no further comment here.

Modifications of this list adopted here comprise (*a*) addition of *Orphiclinus greeni* Scott, 1936 (described since publication of Check-List); (*b*) addition of *Gillias macleayanus* (Lucas, 1891) (first Tasmanian record—with redescription and figure—below); (*c*) restoration of *Gillias clarkei* (Morton) to the genus, *Tripterygion,* in which it was placed by its author; (*d*) relegation of *Petraites incertus* McCulloch to the synonymy of *P. forsteri* (Castelnau).

Notes are given on specimens of *Ophiclinus greeni* from a new locality, and on the appearance in early local lists of *Salarias maleagris* Cuvier and Valenciennes, 1836.

KEY TO BLENNIIDAE AND CLINIDAE RECORDED FROM TASMANIA

1. Much elongated; depth $>$ 6 in length to hypural. Pectoral fin extending halfway, or less, towards vent. One continuous dorsal fin ... ... (2)
Less elongated; depth $<$ 6 in length to hypural. Pectoral fin extending more than halfway towards (sometimes beoynd) vent. Two or three more or less distinct dorsal fins, which may be connected or separate ... ... (3)

2. One continuous dorsal fin, consisting almost entirely of spines; approximately of even height throughout. Body with small, imbedded, non-imbricating scales. Pectoral fin larger than eye ... ... *Ophiclinus*
D. XLVIII-XLIX, 1. A. III, 31-32. Total length about 70mm. ... ... *O. greeni*

3. Two dorsal fins; first consisting of spines, second either wholly of soft rays, or chiefly of spines with a few soft rays. Body naked, or with small, more or less imbedded, non-imbricating scales ... ... (4)
Three distinct dorsal fins; first and second consisting of spines, third of soft rays. Body with well-developed, normal, imbricating scales ... (8)

4. Body naked. The two dorsal fins closely connected by membrane, point of junction being indicated by notch in external margin of fins. First dorsal with about 12 spines. Second dorsal with about 18 soft rays; its base $<$ 2 base of first dorsal. In lower (and upper) jaw a single posterior curved canine on each side; rest of teeth long, slender, in contact with each other throughout most of their length, forming a palisade-like row ... ... *Blennius*
D. XII, 17-19. A. II, 18-20. Total length about 110mm. ... ... *B. tasmanianus*
Body with rudimentary or small, non-imbricating scales. The two dorsal fins partly connected by membrane, or separate. First dorsal with 3, rarely 2, spines. Second dorsal with about 25-35 spines, followed by about 2-8 soft rays; its base $>$ 4 base of first dorsal. In each ramus of lower jaw a symphysial patch of villiform or cardiform teeth, followed laterally by larger, well-separated teeth in one or more rows ... ... (5)

5. First dorsal spine placed over, or in front of, eye ... *Cristiceps*
First dorsal spine placed rather behind middle of eye; about twice third spine. First and second dorsal fins sometimes connected by membrane, sometimes separate. Soft rays of second dorsal equidistant. D. III, XXVI-XXIX ; 6-8. A. II, 24-26. Total length about 100mm. ... *C. australis*
First dorsal spine placed behind eye ... (6)

6. Last (third or second) spine of first dorsal connected by membrane to middle, or upper half, of first spine of second dorsal ... *Clinus* (7)
Last (third) spine of first dorsal connected by membrane to basal portion only of first spine of second dorsal ... *Petraites*
First dorsal spine placed less than one eye-diameter behind orbit; about twice third spine. Maxillary extending to level of posterior orbital margin. Snout about 1.5 eye. D. III, XXIX ; 4-5. A. II, 23-24. Total length about 250mm. ... *P. forsteri*

7. First dorsal spine placed less than one eye-diameter behind eye; subequal to third spine. Maxillary not extending to level of posterior orbital margin. Snout rather shorter than eye. In lower jaw lateral teeth not much larger than anterior teeth of the cardiform symphysial patch. D. III, XXII-XXIV ; 3-5. A. II, 24-26. Total length about 100mm. ... *C. perspicillatus*
First dorsal spine placed more than one eye-diameter behind eye; subequal to third spine. Maxillary extending beyond level of posterior orbital margin. Snout rather longer than eye. In lower jaw lateral teeth many times larger than teeth of the villiform symphysial patch. D. II-III, XXXII-XXXIII; 5-6. A. II, 25-26. Total length about 375mm. ... *C. johnstoni*

8. Head naked ... *Tripterygion*
Scales large ; head scaleless. Lateral line terminating below eighth ray of third dorsal. Teeth villiform; several maxillary caniniform. D. III, XVI, 11. A. 23. Total length about 75mm. ... *T. clarkei*
Head partly scaly ... *Gillias*
Scales on body (except pectoral base), occiput, preoperculum (part), operculum (part) ; ctenoid, except on breast, where they are cycloid. Lateral line following curve of back to level of fourth (? eighth) ray of third dorsal. Teeth in jaws subequal. D. III, XIV, 10-12. A. 22. Total length about 75mm. ... *G. macleayanus*

Genus **Petraites** Ogilby, 1885

Petraites forsteri (Castelnau, 1881)

Cristiceps forsteri Castelnau, *Proc. Zool. Acclim. Soc. Vict.* i. 1872. p. 132.

Petraites incertus McCulloch, *Proc. Linn. N.S.W.* xl. 2. 1915. p. 275. pl. xxxvii. fig. 3.

Remarks.—Though *Cristiceps forsteri* Castelnau appears under the genus *Cristiceps* Cuvier and Valenciennes, 1836, in the Australian Check-List, it is clearly referable to *Petraites* Ogilby, 1885, as delimited by McCulloch (1908, p. 37).

In concluding some observations on *Petraites incertus* McCulloch, the type locality of which is River Tamar, Tasmania, I quoted (1935b, p. 71), and subscribed to, McCulloch's statement regarding the relationship exhibited by specimens of *Petraites incertus* to descriptions of some of the early, imperfectly characterized members of the genus, 'they do not wholly agree with any of the descriptions' (McCulloch, 1915, p. 276). In the course of preparing the key given above, however, I found myself unable to distinguish satisfactorily between *Cristiceps forsteri* Castelnau and *Petraites incertus* McCulloch. The former species is said by Johnston (1883, p. 121) to be common: I have, however, not seen specimens identified as Castelnau's species, and Dr. Joseph Pearson, Director, Tasmanian Museum, Hobart, and Mr. George Mack, Ichthyologist, National Museum, Melbourne, inform me that there are no specimens thus labelled in the collections of their respective institutions. On the other hand, examples clearly determinable as *Petraites incertus* McCulloch appear to be by no means uncommon in Tasmania. I think it likely, therefore, that McCulloch's account of *P. incertus* represents a redescription of Castelnau's species; and, on available evidence, it seems a step forward in our gradual progress towards clarification of the obscurity still largely enveloping our Blennies to sink the former species in the synonymy of the latter.

As *Cristiceps forsteri* the species is known from Victoria and Tasmania: under McCulloch's name it is recorded only from Tasmania, the only accounts of it apparently being the original description and the notes contained in an earlier part of the present series of observation.

Genus **Tripterygion** Risso, 1826

Tripterygion clarkei Morton, 1888

Triptergium clarkei Morton, *Pap. Roy. Soc. Tasm.* 1887 (1880). p. xlvii and p. 78. *Id.* Hall, *Pap. Roy. Soc. Tasm.* 1912 (1913), p. 82.

Gillias clarkei McCulloch, *Mem. Aust. Mus. Sydney.* V. III. 1929. p. 348. Probably not *Gillias clarkei* Whitley, *Pap. Roy. Soc. Tasm.* 1929 (1930), p. 65: *ex* Johnston MS.

Remarks.—Originally described in the genus *Tripterygium* [= *Tripterygion*] Risso, 1826, this species is referred in the Australian Check-List to *Gillias* Evermann and Marsh, 1900. It should, however, probably not be placed in the latter genus. Thus *Gillias*—*fide* McCulloch (1927), p. 86)—has head scaly, whereas original description of species states 'head scaleless'; again, *Gillias* is noted (Jordan and Evermann, 1900, p. 3186) as having D. III; XI; 7, as against III; XVI; 11 in Morton's species. It is doubtful if our present knowledge of this fish is adequate for a definite generic determination: pending the acquisition of further data, it is here provisionally restored to the genus in which it was placed by its author.

I can find only four references, apart from entries in faunal lists, to this species: (*a*) a note in the journal of this Society that apparently records the exhibition of the holotype at the meeting of 15th August, 1887; (*b*) original description (Morton, 1888, p. 78); (*c*) some observations by Hall (1913, p. 82) on coloration, based on some twenty specimens, 1.5-3 inches long, captured 'among the piers, Hobart, August, 1909'. Hall states later (p. 84) that specimens mentioned in his paper 'will be additions to the Tasmanian Museum,' but Dr. Pearson, who has kindly made a search at my request, informs me this material cannot now be traced; (*d*) Whitley (1929, p. 65) quotes a short description of 'Blenny, *Tripterygium sp.*' from Leven, from Johnston MS, and refers this fish to *Gillias clarkei*. From Johnston's description, however, I very much doubt if his specimen is conspecific with Morton's. It is quite possible the specimen noted in Johnston's MS is that mentioned in the following sentence occuring in the Proceedings for August, 1887: 'Mr. Morton also submitted a new species of the genus *Tripterygium*, a genus hitherto unrecorded in Tasmania, although Mr. Johnston had a specimen, of a different species, but had not described it.' Johnston's memorandum (Whitley, 1929, p. 65) notes D. 21/8, *i.e.*, presumably, III.; XVIII; 8, which seems decidedly different from Morton's D. III.; XVI. 11.

Genus **Gillias** Evermann and Marsh, 1900

Gillias macleayanus (Lucas, 1891)

(Text fig. 2)

Tripterygium macleayanus Lucas, *Proc. Roy. Soc. Vict.* (n.s.), iii. 1890 (1891). p. 9 and p. 12. pl. III. fig. 4.
Gillias macleayanus McCulloch, *Mem. Aust. Mus. Sydney.* V. III. 1929, p. 348.

Record.—Specimen (Reg. No. 918FR) collected in rock pool at mouth of Currie River, Northern Tasmania, by Mr. G. R. F. Green, 30th January, 1936. First record for Tasmania.

Generic Status.—*Tripterygium macleayanus* Lucas is referred in the Australian Check-List (McCulloch, 1929) to the genus *Gillias* Evermann and Marsh, 1900, and this procedure is provisionally followed here. I have not access to the original description of the genus, but perusal of a diagnosis published a few months later by Jordan and Evermann (1900), which Mr. George Mack, Ichthyologist, National Museum, Melbourne, has been good enough to transcribe for me, suggests this attribution is doubtful. In the light of modern developments, including the description by McCulloch and Waite (1918) of several endemic South Australian genera, the generic status of various Australian Blennies at present referred to this genus, to *Tripterygion* Risso, 1826, and to allied genera appears to call for revision, a task for which literature and material available here are unfortunately inadequate. The possibility that this species is a synonym of *T. clarkei* Morton should not be altogether overlooked.

Remarks.—Hitherto known only from Victoria. The fairly short original description and small outline figure, based on a single specimen, 50 mm. long, from the Bracebridge Wilson material of 1888-9, do not seem since to have been supplemented: a redescription and a figure (Text fig. 2) are here offered.

Description.—Br. vi. D. iii; xiv; 10. A. i, 21. P. 12 + 6. V. 2. C. 13 + $\frac{4}{5}$. Depth of body at vent 6.3 in total length, 5.2 in standard length. Head 3.8, length to vent 2.3, in standard length. Interorbital width 4.9 in eye, which is 3.4 in head. Snout 1.4 in eye, 4.6 in head. Depth of caudal peduncle greater than its own length, 3.1 in head.

Head large, subconical, its depth 1.3 in its width; naked, except for small ctenoid scales that extend forward on occiput to level of the orbital tentacle, on to whole width of upper fifth of preoperculum, and on to anterior two-thirds of upper half of operculum. Numerous well-developed pores, including double closely set row below eye, two mesial rows on dorsal surface of snout, fairly widely spaced row fringing preoperculum, about half a dozen below on each ramus of mandible: none on operculum. Anterior nostril tubular, broader than high, equidistant from orbit and upper lip, at 9 o'clock relative to eye (left aspect); surmounted by divided subtriangular flap. Posterior nostril a simple opening, close to orbit, at about 11 o'clock. Small hand-shaped ocular tentacle at about 1 o'clock. Row of minute fringed papillae above and behind orbit. Eye large, cutting dorsal profile, longer than high, set obliquely, its major axis at about 45° to the horizontal. Interorbital space slightly concave, with median depression, in hinder half; almost flat in anterior half. Lips large and thick, markedly protuberant, upper projecting slightly beyond lower; maxillary reaching to below hinder third of eye. Maxillary teeth uniserial, subconical, subequal; broad villiform vomerine arc; anterior portion of palatines with clustered large mammillary teeth; mandibular teeth in fairly broad cardiform patch near the symphysis, becoming uniserial laterally.

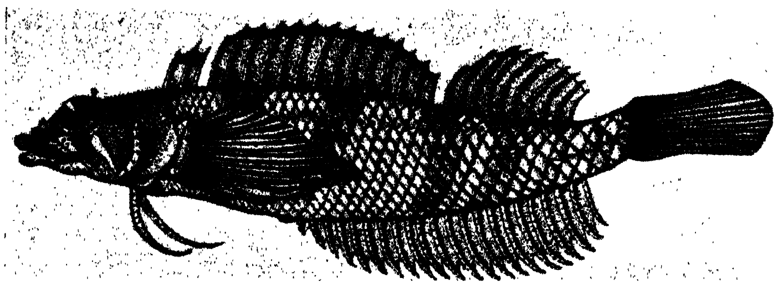

Fig. 2.—*Gillias macleayanus* (Lucas). Total length 53.75mm.

Body stout, its width at shoulder subequal to its height there, at origin of third dorsal about half its height there. Except for the pectoral base, wholly covered with scales, which are small and cycloid on breast, large and finely ctenoid on sides: 34 rows of scales from axilla to hypural, beyond which are one or two rows on bases of caudal rays. Counting obliquely backwards from origin of first dorsal, rows of scales number 3/1/8; or, from origin of third dorsal to base of anal, 2/1/5 (¹). Lateral line subparallel with dorsal profile, from which it is distant about one-fourth as far as from ventral profile; continued to below fourth ray of third dorsal (25 scales), with indication of extension (specimen damaged) to below eighth ray of third dorsal (29 scales). A slight mediolateral groove, apparently without perforations, extends forward from caudal base to level of about eighth ray of third dorsal.

First dorsal fin originating about midway between levels of preopercular and opercular margins; length to origin 4.2 in standard length; base 3.8 in head, about half combined eye and snout; first, second, third spines respectively 32, 35, 29% of head. Interspace between first and second dorsals 5.0 in snout, slightly less than interorbital width. Second dorsal originating shortly behind level of upper angle of pectoral base; length to origin 3.1 in standard length; base 1.3 times head, subequal to length from anterior margin of eye to vent; first, ninth, (longest), fourteenth spines respectively 35, 45, 20% of head. Second interorbital space subequal to first Third dorsal with the first five rays very feebly and briefly divided, the sixth, eighth, and tenth, which are the only undamaged rays of the remainder, simple; originating about as far behind vent as vent is behind pelvics, terminating about above penultimate anal ray; length to origin 1.5 in standard length; base 1.3 in head, subequal to depth of body; first, sixth (longest), tenth rays respectively 37, 49, 30% of head; laid back, fails to reach level of base of caudal rays by less than an eye-diameter. Anal with all rays simple, much stouter than those of the third dorsal, the membrane incised to a depth of more than one-third length of the rays; originating below sixth spine of second dorsal; length to origin 2.2 in standard length; base 1.8 times head, subequal to length to origin of the fin; extending behind end of third dorsal by twice interorbital width; spine, first, eleventh, twenty-first (longest), twenty-second rays respectively 12, 21, 43, 46 30% of head; laid back, extends slightly beyond base of caudal rays. Pectoral long, pointed; with upper rays slender, divided in their outer third or half; lower rays, between which membrane is markedly incised, not divided distally, but with the rib appearing as two separate ridges in the proximal two-thirds or four-fifths; originating

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(¹) The former convention is evidently that adopted in the original description of the present species (Lucas, 1891): the latter permits of comparison with the description of species ascribed to *Tripterygium* by Ramsay and Ogilby (1888a; 1888b).

behind pelvics by about an eye-diameter; length to origin 3.9 in standard length; longest (tenth) ray 1.2 times head; laid back, reaches to below penultimate spine of second dorsal. Ventral with the stout simple rays separate for nearly their whole length; originating about below preopercular margin, four-fifths of length of snout in advance of dorsal origin; length to origin 5.1 in standard length; outer, more anterior ray 1.3 in inner, more posterior ray, which is 1.2 in head. Caudal with all major rays branched up to nearly half their length, except lower two rays, which are simple, and decidedly stouter than upper two; length of median rays 4.4 in standard length, 1.2 in head.

Genital papilla moderate, longitudinally plicate.

General colour in formalin yellowish-grey, becoming flesh-coloured on the anterior half of the preanal ventral surface. About eight subvertical dark-brown bars, best developed anteriorly; first immediately behind pectoral base, second and third below second dorsal, fourth below interspace between second and third dorsals, fifth and sixth below third dorsal, seventh near middle of caudal peduncle, eighth at base of caudal rays: eight similarly coloured saddles on back, five posterior continuous with the lateral bars, the three anterior ones from third increasingly in advance of corresponding bars. General colour of head dark greyish-brown dorsally and laterally, concolorous ventrally with sides of body. Two conspicuous light-coloured, dark-bordered genal bands, running downwards and backwards from front and rear of lower edge of orbit: a less conspicuous, similarly coloured, band fringing preoperculum, preceded by dark band. Dark patch below eye; broad dark band extending forward from front of eye across upper lip, the latter elsewhere dark greenish-brown; tip of snout brown, the colour continued back as a narrow stripe to interorbital region. Lower lip concolorous mesially with throat, darker laterally. Eye greyish-blue. Dorsal fins greyish, heavily speckled on membrane and spines, and to lesser degree on rays, with dark brownish; first and second dorsals narrowly fringed with blackish along free margin. Anal greyish, less heavily punctulated than dorsals; tips of rays whitish. Pectoral greyish, the membrane lightly, the rays, especially at base, heavily, punctulated with brownish. Pelvic whitish. Caudal pale greyish, moderately dotted with brownish on membrane, slightly on rays.

Described and figured (Text fig. 2) from a specimen of total length 53.75 mm., standard length 43.75 mm., in the collection of the Queen Victoria Museum (Reg. No. 918FR).

Variation.—Examination of a range of specimens may show this fish is distinct from Lucas' species: with only one individual available, it seems advisable for the present to assume identity.

Chief differences from holotype exhibited by present specimen; two fewer rays in third dorsal; three more rays in pectoral; rather smaller eye; level of anal origin further forward along base of second dorsal than shown in Lucas' figure.

The marked differences in coloration—the holotype (in spirit) is described as orange, with red vertical bands; eye red—are probably attributable to the use of different media for preservation: attention has previously been called (Scott, 1936, p. 123) to variations in colour of blennies in alcohol and formalin (1).

Family OPHICLINIDAE

Genus **Ohpiclinus** Castelnau, 1872

Ophiclinus greeni Scott, 1936

Ophiclinus greeni Scott, *Pap. Roy. Soc. Tasm.* 1935 (1936), p. 114, fig. 1.

Record.—Two specimens, of total length 75.0, 62.0 mm., standard length 68.0, 56.5 mm. (Reg. No. 806, a-b), collected in rock pools at mouth of Currie River, Northern Tasmania, by Mr. G. R. F. Green, on 3rd January, 1936.

Remarks.—The species has hitherto been known only from the holotype and two paratypes, the type-locality being Lady Lucy Beach, Low Head, Northern Tasmania. In addition to providing a new locality, the present specimens are of importance in that they both considerably exceed in size the largest specimen previously known—larger individual is one and a half times as long as larger paratype, which has total length 49.8 mm., standard length 45.5 mm.—and afford some interesting data regarding variation of proportion with general size.

Proportions.—Large individual noted first [values in square brackets show range exhibited by holotype and two paratypes, 34.3-49.8 mm. in total length, 31.9-45.5 mm. in standard length]. Depth 7.7, 8.8 [7.7-8.2] in total length; 7.0, 8.1 [6.4-7.5] in standard length: depth at level of first anal ray 7.9, 9.3 [7.7-8.9] in total length; 7.2, 8.4 [6.9-8.1] in standard length. Head 6.4, 6.1 [4.9-5.7] in total length; 5.8, 5.5 [4.4-5.2] in standard length. Eye 6.5, 6.4 [5.3-6.1] in head; 1.5, 1.4 [1.2-1.5] in snout; 1.3, 1.1 [1.1-1.2] in tail without caudal fin.

It will be seen that with increase in size of the fish are correlated decrease in length of head, relative to total, or to standard, length; decrease in diameter of eye, relative to length of head; and decrease of combined length of head and trunk, relative to tail without caudal fin. The first two variations are, of course, characteristic of many fishes; and there is evidence to show that, with advancing age, increase of length of the postanal, relative to the preanal, portion of the body is not uncommonly encountered in Blenniid fishes.

Maxillary extends to level of middle (smaller specimen), or hinder four-fifths (larger specimen), of eye.

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(1) Recently Myers (1936, p. 83) has discussed the significance in certain Albulid fishes of longitudinal dark stripes observed in formalin specimens, the presence or absence of which is possibly connected with the nature of the preservative used.

Fin-Formulae.—Larger individual noted first. D. XLVIII, 1; XLIX, 1. A. III, 32 (both specimens). P. 12; 11. V. 2 (both) C. 13 + [illegible]; 13 + [illegible].

Genus **Salarias** Cuvier, 1829

Salarias meleagris Cuvier and Valenciennes, 1836

Salarias meleagris Cuvier and Valenciennes, *Hist. Nat. Poiss.* XI. 1836. p. 332.

Remarks.—Type-locality is given as 'Terre de Van-Diemen' (Péron); and the species is included by Johnston in both his Tasmanian lists, since which, however, it has been dropped from all local catalogues. In their review of some Australian Blennioid Fishes McCulloch and McNeill state (1918, p. 17): 'This species was said to have been originally obtained by Péron in Tasmania, but no species of the genus occurs so far south. Johnston (1883, p. 121) noted that it was common in Tasmanian waters, but his reference doubtless applied to *Blennius tasmanianus*.' In the Australian Check-List the Australian range is given as Queensland, Northern Territory.

The comment made by McCulloch and McNeill regarding the confounding on Johnston's part of this species with *Blennius tasmanianus* Richardson, 1849, may perhaps appear a rather sweeping and over-facile one: it is, I believe, nevertheless, almost certainly correct. As the result of examination of a considerable number of specimens of *Blennius tasmanianus*, I find that while in the majority the conformation of the anterior portion of the head is much that shown in the well-known figure by Waite (1906, pl. XXXVI. fig. 5)—*i.e.*, dorsal profile of snout sloping backwards at about 45°; snout little less than, often greater than, eye; mouth-cleft markedly oblique (about normal to dorsal profile of snout), reaching to about middle of eye—occasional individuals have a decidedly *Salarias*-like facies, the dorsal profile of the snout being subvertical, making length of snout barely more than half eye, and bringing mouth-cleft, which now extends about to posterior orbital margin, virtually horizontal.

Family GOBIIDAE

A recent revision of the Tasmanian members of the family (Scott, 1935a) credits our fauna with three species, representing as many genera: *Nesogobius hinsbyi* (McCulloch and Ogilby, 1919); *Arenigobius tamarensis* (Johnston, 1883); *Tasmanogobius lordi* Scott, 1935.

A note on *Arenigobius tamarensis* appears below, and a key to the local gobies is supplied.

KEY TO GOBIIDAE RECORDED FROM TASMANIA

1. **Body with well-developed normal scales. Second dorsal with < 12 rays; its base < 2 (about $1\frac{1}{3}$) base of first dorsal .... (2)**
   Body without normal scales. Second dorsal with > 12 rays; its base > 2 (about 2½) base of first dorsal .... (3)

2. Rows of scales between axilla and hypural < 40. Tongue notched anteriorly. Spines of first dorsal never > 6 .... *Arenigobius*
D. VI, 9. A. I, 8 . Rows of scales between axilla and hypural 32-33. General colour greenish-grey or greyish-brown, becoming whitish or pale greenish-grey below; vertical bars on side, if present, about 4, not descending below midlateral line .... *A. tamarensis*
Rows of scales between axilla and hypural > 40. Tongue rounded anteriorly. Spines of first dorsal usually > 6 .... *Nesogobius*
D. VII (rarely VI)-VIII, 9-12. A. I, 8-11. Rows of scales between axilla and hypural 50. General colour sandy above midlateral line, white below; usually about 12 narrow subvertical bars on side, often descending below midlateral line .... *N. hinsbyi*

3. Body with pectinate groups of microscopic spines, arranged in staggered rows, often invisible without dissection .... . . *Tasmanogobius*
D. VI-VII, 15-16. A. I, 13-15. In life virtually transparent, with small fawn markings .... *T. lordi*

Genus **Arenigobius** Whitley, 1930

Arenigobius tamarensis (Johnston, 1883)

Gobius tamarensis Johnston, *Pap. Roy. Soc. Tasm.* 1882 (1883), p. 120.

Arenigobius tamarensis Scott, *Pap. Roy. Soc. Tasm.* 1934 (1935), p. 50, pl. IV, fig. 1 (references and synonymy).

Record.—This species, which appears to have remained unrecognised during the fifty-odd years between the publication of the original description and the provision of a redescription and figure in the revision of the Tasmanian Gobiidae cited above (Scott, 1935a), has hitherto been know only from the type-locality, River Tamar, Northern Tasmania.

It may now be recorded from the East Coast, two specimens of total length 51, 58 mm., standard length 41, 47 mm. (Reg. Nos. 943, a-b) being included in a sample of 'Prettyfish' collected at Swansea by Mr. H. W. A. von Stieglitz: received 18th December, 1934. 'Prettyfish,' it may be observed, is a collective term for various small fishes used as bait at several fishing resorts on the East Coast. The constituent species not improbably vary with locality and season: in the present instance, the two gobies are associated with 14 specimens of *Atherina microstoma* Günther, of total length 49-72 mm., av. 59 mm.

SUMMARY

1. Some general observations are made on *Arripis trutta* (Bloch and Schneider, 1801), *Petraites forsteri* (Castelnau, 1881), *Petraites incertus* McCulloch, 1915, *Tripterygion clarkei* Morton, 1888, *Ophiclinus greeni* Scott, 1935, *Arenigobius tamarensis* (Johnston, 1883).

2. Little-known species described and figured are *Leptonotus semistriatus* Kaup, 1856, *Gillias macleayanus* (Lucas, 1891).

3. Additions to the Tasmanian faunal list comprise *Leptoichthys fistularius* Kaup, 1853, *Arripis georgianus* (Cuvier and Valenciennes, 1831).

4. The inclusion in the local lists of *Corythoichthys phillipi* (Lucas, 1891), *Salarias meleagris* Cuvier and Valenciennes, 1836, is discussed.

5. Keys are supplied to the Tasmanian members of the families Syngnathidae, Arripidae, Blenniidae, Gobiidae.

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PAP. & PROC. ROY. SOC. TASMANIA, 1938 (24TH MAY, 1939)

Note on Pleistocene Glaciation Mt. Field to Strahan

By

A. N. LEWIS, LL.D.

(Read 14th November, 1938)

This paper is an attempt at a general correlation of Tasmanian glacial features along a section from east to west of the glaciated portion of the State. The area chosen for this survey has already been the subject of a number of detailed descriptions and the influence of ice on its topography has been known in part since Charles Gould's first record in 1861 and in detail since R. M. Johnston's account in 1893. The few new areas in which traces of glaciation are here recorded do little more than connect up previous accounts. This paper may be regarded as supplying examples in support of my correlation of Tasmanian Pleistocene Glacial epochs and deposits (Lewis 1934). I now confirm, with a few modifications, the ideas then advanced and am able to clear up points which I then felt to be open to some doubt.

1. SUMMARY OF PREVIOUS ACCOUNTS WITH NEW RECORDS

Mt. Field

This area, on the eastern extremity of the glaciated zone, shows the typical topography of intense mountain glaciation down to the 2500 feet contour or a little less. It has been fully described (Lewis 1922 and 1923, Griffith Taylor 1922) and I have no further observations to record.

Florentine Valley

Previously, glaciation had been recognized to the east, south and west of this area but previous investigators had not recorded glaciation in the Florentine Valley itself. The reason for this has probably been that the Florentine is covered by dense virgin forest concealing the topographical details while the bare plains of the neighbouring Gordon and Huon valleys display their glacial features to perfection. However, as the results of a visit at Christmastime 1937, I have no hesitation in saying that the upper half of the Florentine Valley was subject to glacial action as severe as was the Vale of Rasselas. This is to be seen clearly from the Adamsfield track on the northern slopes of Tim Shea, and as it crosses the Thumbs-Saw Back saddle. The headwater tributaries of the Florentine rise in a wide arc of cirques on the northern flanks of Mts. Mueller, Bowes and Wedge. The less heavily timbered upper portion of the valley south of the Adamsfield track shows a glacial topography not essentially different from that of the upper Huon and Gordon rivers. The Tiger and Gordon ranges show the typical planing action of a major glacier along both flanks, as do the lower slopes of Mt. Field West. Spurs have been shorn and the whole floor of the Florentine Valley, at least as far north as Dawson's Road, or even an east-west line through Wyld's Crag, shows all the typical features of glacial topography. Morainal deposits abound for miles on both sides of the Florentine bridge on the Adamsfield track. It appears at present that ice descended to at least the 900-foot contour and perhaps lower. There has however been considerable post-glacial river erosion below that level.

Russell Falls River Valley

Glacial action is apparent in the saddles on both sides of Tim Shea, on the slopes of the Needles and over Mt. Mueller where cirques and at least one tarn occur. There is some slight suggestion of ice action as low as Kallista (1100 feet) but stream erosion has been more active on the steeper slopes of this valley and I cannot definitely confirm glacial evidence below 1500-1600 feet in this area.

Weld Valley

There appears to be some slight remains of glaciation north west of Mt. Anne at, perhaps 1100-1500 feet. The head of the Weld-Styx valleys are heavily timbered and observations are difficult.

Adamsfield

This area is also glaciated, although the short swift tributaries of the Gordon (Adam, Boyd, &c.) have been responsible for a high degree of post glacial erosion (See also Nye 1929, A. M. Reid 1921).

Vale of Rasselas, Denison Range and King William Ranges

The Gordon Valley from its source in Lake Richmond, down to the Great Bend, and its bounding ranges are all excellent examples of Tasmanian glacial topography. The fact that the whole of this area was heavily glaciated has been known since R. M. Johnston's early investigation (See e.g. Johnston 1894, Twelvetrees 1908, Reid 1921).

The mountains are dotted with large lakes and small tarns and the Vale of Rasselas is glaciated to the Great Bend at 1550 feet. Below this spot the eastward erosion of the river which is now the westerly flowing section of the Gordon has destroyed evidence of ice action but the glacial topography is continued unbroken across the almost negligible saddle of Myrtle Creek to the Florentine Valley.

Lake St. Clair

This area has been fully described by several observers, particularly W. H. Clemes (Clemes 1925, and see references to previous works there cited). I have nothing to add to these accounts except the interesting fact, which came to light during the surveys for the Tarraleah Power Scheme, that the floor of Lake St. Clair (700 feet deep) is lower than the bed of the Derwent for 10 miles down its course, that is to the top of Butler's Gorge, where the post glacial erosion of the Derwent River cuts into the glacial physiography. Mr. Clemes's account connects with the adjoining area to the north east already described in detail my myself (Lewis 1933).

Surprise Valley

The West Coast Road has opened up a wonderful section of glacial country. In fact it was in this section that Charles Gould in 1861-2 first discovered the occurrence of pleistocene glaciation in Tasmania (? Australia, see Johnston 1894). For 65 miles, from the Clarence to Gormanston, this road traverses an unending vista of moraine strewn glacial valleys with cirques never out of view. The eastern portion of this area has been fully described (Clemes 1925 and other references there specified). From Derwent Bridge where the road crosses the lower portion of the St. Clair moraine to King William Saddle (2725 feet), the country is typical of the more open glaciated plateaux. From the road at King William Saddle is to be seen the cirque system at the head of the Surprise Valley. The road drops from 2725 feet on the saddle to 1200 feet at the junction of the Surprise and Franklin Rivers, and this marks the vertical height between the country affected by two glacial phases. The whole floor of these valleys is glaciated although this fact is partly obscured by the heavy growth of timber. The glacial evidences at the head of the Franklin River (Lakes Undine and Dixon) have been well described (Johnston 1894, Clemes 1925) but the Surprise Valley is no less intensely glaciated with a remarkable 'tind' in the middle. Under Mt. Arrowsmith and Mt. Hardy some fine examples of moraines are exposed in the road cuttings.

Collingwood Valley

The road runs along the bottom of a typical glaciated valley here. The northern slopes of the Collingwood and Raglan Ranges as seen from the road present, in a remarkably clear way, the W pattern of shorn spurs. Hanging valleys and superimposed cirques can be seen everywhere. Glacial action extends right up to the top of the Collingwood-Nelson Saddle west of King Billy.

Nelson Valley

Here the road runs, at first, high up on the side of a typical glacial valley. The characteristic shorn spurs are seen, this time, from above. The road enters the Nelson Valley also over the crest of a cirque. No more typical example of glacial erosion can be seen anywhere.

King River

This valley has been the collecting ground for a large sheet of ice descending in many tributaries glaciers from all the surrounding mountains (See Johnston 1894). Its broad floor is now covered with morainal material largely restored by post-glacial floods.

Linda Valley

This short valley provides the most spectacular example of glacial topography in the whole State and the destruction of all vegetation and humus by firewood getters, sulphur fumes and heavy rains has revealed the rocks as much as the glaciers left them. This and neighbouring areas have been well described (Moore 1894, Gregory 1903, Hills 1914, David 1924 and Lewis 1936) and I have nothing further to add.

Queenstown

A remarkable change in topography presents itself as the Linda Gap is crossed from Gormanston on the road to Queenstown. The open vista of the perfect glacial valley crowned by the huge Gormanston moraine gives place to a confused jumble of waterworn gorges. These are the head waters of the Queen River, which have cut easterly into the western slopes of the West Coast Range and here have removed all trace of glacial topography. The same has occurred in the Comstock Gap to the north. (Nye and Blake 1938, p. 15). Evidence of ice action is again apparent in a tributary valley north of the saddle at Renedeena on the Mount Lyell Railway between Lynchford and Renedeena. In the valley of the King River, south of the saddle, the traces of glaciation have likewise been largely removed (See David 1924).

Strahan

It is clear that final confirmation of the various theories relating to superimposed glaciations must be sought at the edge of the glaciated area. Unfortunately this evidence has been destroyed in most localities by post-glacial erosion. However, at Strahan a most instructive, if confusing, section is to be seen. The Strahan terraces are well known and their glacial origin is recognized (see David 1924 p. 116 and plate XI). The recently constructed Strahan-Queenstown road has opened up a section which provides remarkable confirmation of Sir Edgeworth's explanation of these terraces and which deserves a brief description.

The road winds out of the Queen River basin (largely post-glacial river topography) on to Howard's Plains and thence a distance of approximately 20 miles across the 'Henty Peneplain' reaching a height of 1100 feet above sea level at a spot just north of Renedeena. Thence it descends to 550 feet at a distance of 3 miles from Strahan. This area is occupied by white brachipod sandstones of the Queen River Series (Silurian) with included grey slates and white to green. tuffs and porphyry. These rocks end at a large cutting on the western slope of the peneplain 3 miles from the boundary of the Strahan township and 550 feet above sea level.

From that spot a well preserved glacial moraine is exposed in the numerous road cuttings. This is mostly dark yellow to greyish clay full of grits, pebbles and boulders, numerous ones of which show distinct ice scratches. As far as can be observed in this section the maximum height of this moraine is 600 feet above sea level and it descends on the terraced slopes east of Strahan to 300 feet above sea level. This by no means necessarily records the thickness of the moraine but on the section in question the till is replaced at 300 feet by the Strahan terraces. Its absolute thickness in a vertical section may be much greater but no exposure could be found to indicate this.

The Strahan terraces are at three distinct levels. The top of the highest (more easterly) averages 300 feet. The top of the second, upon which the central portion of Strahan is built and which extends westward to the ocean beach, averages 60-75 feet above sea level. The lower terrace is to be seen as a narrow margin round Macquarie Harbour and rises from 5 to 25 feet above sea level. The moraine mentioned above abuts on the 300 foot terrace and appears to merge into it. The terraces all appear to consist of blown sand, river grit and partly rounded but ill sorted pebbles averaging 2 inches in diameter with a few larger ones. Layers of peat sometimes two feet or more in thickness are included. No consistent arrangement of strata can be observed. The pebble bands vary from a few inches to twenty or more feet in thickness and are distributed without apparent arrangement amongst the sandy accumulations. The arrangement of the whole series bears no relationship to existing topography. Much of the sand is clearly river or fresh water grit. No sign of sea life can be found and aboriginal artifacts are conspicuously absent. The western edge is covered by very recent sand dunes. No distinguishing feature, or in fact any difference other than height, can be identified between the various terraces. Their depth is unknown. They show no traces of varves (see also David 1924 p. 116

for a section of the 60 foot terrace at Strahan railway station which may be taken as typical of the whole series subject to frequent local variations).

In my opinion, the Strahan terraces are all of the same age and are, taken as a whole, contemporaneous with the moraine immediately to the east. At Malanna, the moraine described by Sir Edgeworth David appears to overlie blown sand and pebble deposits undistinguishable from the material of the Strahan terraces. Although no section at Strahan illustrates this so clearly, it appears to me that the same relationship exists at 550 feet 3 miles east of the township. I can find no justification for assuming that the moraine was the product of the earliest glaciation and that the terraces were deposited at lower levels during subsequent glaciations. This is probably the effect produced in river valleys in non-glaciated regions where the terraces lie parallel to the drainage (see Lewis 1935) but such is not the case where the terraces lie at right angles to the direction of the drainage and cover a wide area.

The explanation which appears best to fit all the evidence is that the Strahan terraces were formed from the outwash from melting glaciers or an ice sheet of the Malanna glacial phase. These deposits were laid down originally on a very low and level shore platform or in a wide shallow bay which stretched from Kelly's Basin to Trial Harbour some two to five eastward of the present shore line and perhaps behind a line of sand dunes which may have quite blocked access to the open ocean. In any case the actual floor is not anywhere visible. Some remains of marine life may exist at the level of this floor. A large area was covered with such outwash gravels and blown sea sand was constantly encroaching. Vegetation established itself from time to time but was continually being overwhelmed by newer deposits. There is evidence of very many fluctuations during the deposition with alternations of retreating and readvancing ice, growth and dispersal of sand dunes, accumulation and destruction of peat bogs and forests. There is also evidence that each example of outwash pebble banks, sand dunes and vegetable accumulations were nowhere individually widely distributed and often showed great differences in vertical height with marked erosion effects during the whole period of deposition.

The outwash apron as a whole was widely distributed at first, perhaps further westward than the present coast line. Finally the ice advanced over much of this outwash gravel and actually deposited terminal moraines rising several hundred feet higher. Subsequently to this maximum phase, water flowing from the retreating ice margin assisted to redistribute morainal material in a sharply descending slope to the lower terrace. The present topography is the result of influences ubsequent to the maximum glacial phase—that is to erosion of the moraines and outwash gravels, not entirely to deposition factors.

It is admitted that the absence of sea shell presents a grave objection to any explanation of the formation of these terraces by marine erosion. Sir Edgeworth David also raises the objection that there is no evidence of any terrestrial uplift during the period in question (David 1924 p. 116). However, there is evidence elsewhere of successive rises in the land all over Tasmania (Lewis 1935) and the absence of sea shells may be explained from several causes such as subsequent erosion, or erosion by a virtually fresh water 'inland sea' such as Macquarie Harbour. However, Sir Edgeworth David actually only affirmed that the Strahan terraces were not raised beaches, a conclusion which is now accepted, and my chief point is that the glacial origin recognised by Sir Edgeworth David and proved by the discovery of the moraine immediately to the eastward must be referred to one glacial phase not to three, as may be tempting.

I postulate that the 60 foot terrace and the shore platform at Strahan are referrable to the same positive earth movement as produced the similar features in south eastern Tasmania (Lewis 1935). These are marine erosion features without contemporaneous deposits. The 150 foot terrace noticeable in unglaciated areas is obscured by the higher moraine and outwash gravels.

I also note that the erosion features of the subsequent phases of the Pleistocene glaciation in what I have taken as the type area are to be seen in panorama from the Strahan-Queenstown road near its highest point. The cirque gorge of the Yolande, with the Lake Margaret pipe line, is plainly visible on a clear day. The contour of Lake Margaret is also marked by the pipe line. It is also noticeable that the slope from the top of the Gormanston moraine in the Lyell-Owen Gap to the moraine just east of Strahan represents the natural slope of the western fall of the range prior to the removal of a great portion of the intervening country by the headward erosion of the Queen River.

2. GENERAL CORRELATION

In my previous paper on correlation of glacial epochs, I summarized the arguments advanced in support of a threefold glaciation during Pleistocene times and gave the names Malanna, Yolande and Margaret to the three Tasmanian ice invasions. These ideas worked out well in some localities but I was not very satisfied as to others. Chief amongst the doubtful areas was the Mt. Field plateau where the Margaret ice tarn stage is distinct, and, at 1200-1600 feet lower down the mountain side the remains of the Yolande stage is equally distinct. This Yolande stage is divided into two separate phases showing superimposed cirques, lakes and moraines (See Lewis 1922). However, these two phases are only separated by a vertical interval of 200-400 feet and the time interval did not appear as apparent as in some other localities (e.g. the type area, Henty Valley). On the other hand, if the lower glaciation on Mt. Field did not represent the Malanna stage, this phase was missing here and the temptation to force a correlation was strong.

Similar doubts as to the glaciation of Mt. La Perouse were resolved by observations recorded in 1935 (Lewis and Murray 1936). We there indicated the possibility of a double phase during the Yolande glaciation. The recent discovery of glaciation in the Florentine Valley now provides the confirmation I sought in 1935. This involves the retraction of the statement in my 1933 paper to the effect that the Yolande stage could not be subdivided, which I now amend to read that the second or later phase of this stage cannot be subdivided.

The sequence as now made clear by a consideration of the cross section of glaciated country from Mt. Field East to the Thumbs is as follows:—The Florentine Valley was at one time filled with ice which descended to at least the 900 foot contour and probably somewhat lower. This ice at its maximum must have filled the valley to a height above the saddles east and west of Tim Shea, that is a thickness of 1200 feet at least. At this time Mt. Field plateau was probably entirely covered by an ice cap which did not leave observable traces on the mountain sides—the glacier forming in the Florentine Valley. It is a distinct possibility also, that the final elevation of the plateau occurred subsequently. In any case stream erosion has been very active on the steep slopes and would be sufficient to remove traces of the ice cap on the eastern and southern sides of the plateau. Two distinct glacial phases occurred during the Yolande stage. In the first, the more intense, ice did not descend the plateau valleys quite to the 2400 foot contour, and in the second, below 3000 feet, giving an average difference in the altitude of the nivation layer in the two phases as about 500 feet. In the quite distinct Margaret stage the nivation layer did not descend lower than 4000 feet (See Griffith Taylor 1922).

We thus can identify in Tasmania four separate ice invasions. Of these, the two middle ones occurred in quick succession, relative to the dates of the preceding Malanna stage and the succeeding Margaret stage. I consider that these two middle glaciations should be regarded as both phases of the one stage. We probably see the effects of a rapid onset reaching its maximum intensity relatively early, then a partial waning followed by a second onset less intense and less sustained than the earlier phase. I therefore prefer to retain the name Yolande for the whole glacial invasion, separating it into a first and a second phase where the evidence is sufficient.

This generalization appears to fit all the field evidence, both of glacial topography and river terraces in non-glaciated areas, which latter do not show definite differentiation between the two phases of the Yolande stage. It is the only explanation which will explain the topographical details of all the glaciated country when considered as a whole from east to west and it can only be seen when such a section is studied as a whole.

3. MALANNA STAGE

The remnants of the Malanna glaciation are relatively rare. Mostly, they have been removed by post Malannan river erosion. Through the area under discussion the country consists, in a general way, of plains standing at about 1000 feet above sea level with mountains rising out of them to 3000-5000 feet above sea level. Sometimes the mountains are so closely parallel that the plains become mere valleys. The Malanna stage can be seen on these plains where its features have not been removed by subsequent river erosion or obscured by Yolande glaciers which, where the mountains are high plateaux and the valleys between are narrow, more or less covered the traces of the earlier stage.

The glaciation of the valleys of the Florentine, the Vale of Rasselas, the Huon and Serpentine are attributed to this stage. The same is also the case with Lakes Sorell and Echo and the eastern areas of the central plateau. Any possible glaciation in the Russell Falls and Weld Valleys are likewise referable to this earlier stage. The Surprise Valley is an excellent example of a Malanna cirque and glacial valley. The underlying features of the King River valley and probably of the Franklin and Collingwood Rivers were moulded by Malanna ice flows. The terraces and moraines at Strahan, and the moraines at Malanna are of similar age.

Through the Lake St. Clair valley and thence to the King River there is much morainal material of the Yolande stage strewn over the older glacial valleys along the section traversed by the West Coast road. The Linda moraine is probably a highly eroded fragment of a Malanna moraine. I have already described this feature of outstanding interest (Lewis 1936). It is obviously very ancient and took an immense period to accumulate. I consider that it was deposited in a lake or flat plain. It is clear that this deposition must have taken place when the physiography of the West Coast Range was very different from that presented at the present time. I quite agree with the remarks of Nye and Blake as to the moraines in the neighbouring Sedgwick Gap (Lyell-Comstock) and the relationship of the erosion of the Queen River (Nye and Blake 1938 p. 15). Similar features are apparent in the Linda Gap. Gregory's explanation of glacial features must now be regarded as superseded except as to descriptive detail. Nowhere is the distinction between the Malanna Stage and the succeeding Yolande Stage more pronounced or clearer than in the section from King William Saddle to the Franklin River i.e. the panorama southward from Mt. Arrowsmith. Here the Yolande glaciation of the St. Clair area, extending to the saddle can be seen at 2400-2800 feet and, below, the old forest covered cirques at the head of the Surprise Valley 1000-1200 feet lower. In the same area the traces of the lesser Margaret stage can be seen in the small cirques high on Mt. King William.

The effect of post Malannan uplift is apparent everywhere. The Gordon and the King Rivers and their tributaries have cut deeply into the glaciated valleys (See David 1924). The waterworn topography round Queenstown is a typical example. This waterworn topography extends eastward up the Gordon Valley to the Great Bend and is very marked round Adamsfield. It is carried up the valleys of all the tributaries of the Gordon for some distance. On the other watershed, the Derwent has cut even more deeply into the glaciated area south of Lake St. Clair, having removed all traces of glaciation below the northern end of Butler's Gorge, where the Tarraleah fluming commences. The Nive, Dee and other south flowing tributaries have cut back to the line of the West Coast road or further and the Florentine has cut into its glacial valley to a point west of Mt. Misery. The Russell Falls and Weld Rivers have almost removed all trace of Malanna stage glaciation from their valleys below about the 1500 foot contour.

It is difficult to fix one elevation as the contour to which more recent river erosion has cut. This varies with each stream. In some cases the present river valley has cut into one side of the older Malanna glacial valley, or cut a sharp trog in the old wider valley, leaving traces of glaciation still surviving. In some valleys the tributaries have removed all trace of Malanna glaciation in other places only one or several tributary valleys have been thus affected, leaving a nearly dry glacial valley at a higher level. For this reason, many apparent contradictions exist. However, it appears clear that during the Malanna stage, ice descended to sea level on the coast and to 900-700 feet at least at the meridian of Mt. Picton-Mt. Field-Lake Echo. During this early stage therefore all the western third of Tasmania, with the southern coast, the central plateau and the north eastern plateau must have been under an ice cap, although it was a Tasmania essentially different in topographical details from what we now know.

4. YOLANDE STAGE

The obvious glaciated features of the uplands belong to this stage. In favourable localities glaciers pushed down valleys to about the 2000 foot contour and developed very fine cirques and comb ridges at their heads. These extend upwards to about the 4000 foot contour, above which ice cap conditions left little mark on the topography. This is the stage responsible for the glaciations of the Mt. Field plateau, Mts. Anne and Mueller, the King William Range, the Eldon Range, and many of the valleys of the West Coast Range including Mts.

Jukes and Tindal. The two phases are frequently in evidence. See particularly Plates XI and XIII in my account of Mt. Field (Lewis 1922). Similar features have been described at Lake St. Clair and Du Cane Ranges (Clemes 1924) and Mt. Jukes (Hills 1914), also at Cradle Mountain (Benson 1917 esp. p. 34) and La Perouse (Lewis 1925). Yolande glaciation is also responsible for many details of the features at the head of the Florentine, Gordon and Surprise Valleys and is the glaciation of the western edge of the central plateau and at the headwaters of the King and Pieman Rivers and their tributaries.

The double phase of the Yolande glacial stage follows over the higher mountains of western Tasmania with sufficient regularity to establish the main features of the stage. The difference in level varies considerably but 400 feet is the average difference and its absence in any particular glaciated locality is to be explained from outside causes, usually the obliteration of the first phase by the second or a sufficiently identical development to cause confusion.

To-day therefore, we have advanced beyond the stage when the existence of glacial features are recorded as an item of interest since we can say positively that all the country west of the 147th Meridian and which is over 1000 feet has been subjected to ice action. Where this is not apparent the explanation is post glacial stream erosion. Moreover, the details of the traces of ice invasions as outlined above are consistent throughout this area varying only with such local features as slope and size of neve catchment.

5. MARGARET STAGE

This glaciation was the most recent but as the nivation layer at this time did not descend below 4000 feet on the eastern boundary of the area described to 2000 feet on the West Coast Range, only the higher and more westerly mountains were affected. In some areas this glaciation is very distinct (See Griffith Taylor 1922 and Lewis 1922 Plate VIII, Clemes 1925 p. 71, and Plates XI fig. 1 and XIV fig. 1). Pine Lake (Lewis 1933) is referable to this glaciation as are most of the small lakes and other glacial features in the higher levels of the Lake St. Clair-Cradle Mt. National Reserve, and over the western edge of the Central Plateau. Many of the higher lakes on Mt. King William, Denison and Eldon Ranges belong to this stage but without a detailed examination I am not prepared to draw a definite line in these localities between the Margaret and Yolande stages. The glaciation of this stage at the type locality has been well described (Moore 1894, Montgomery 1894).

There is little to add to these descriptions. Cirques with occasional lakes and frequent moraines referable to the Margaret stage lie dotted over our more elevated highlands. The features produced by this glaciation are seen usually on a definite shelf or ledge cut into the cirque heads of valleys still showing the characteristic features of the Yolande stage. Very often the evidence of the Margaret glaciation is no more than a line of ledges, hollows and miniature cirques round the mountain side at a constant height. In more favoured localities only has this glaciation developed features in any way approaching those of the Yolande stage and then, often, the two stages overlie or merge in a very confusing way. The areas where this glaciation can be established as a distinct stage are those such as Mt. Field, Du Cane Range, La Perouse, and Mt. Anne where the Margaret cirques have distinctly cut into the Yolande cirques. It is often impossible to disentangle the moraines referable to these two stages. However, the evidence of the cirques, ledges and tarns is sufficient to establish the stage as an event quite distinct from both phases of the Yolande glaciation. The best description of the features of this stage were given by T. B. Moore (1894) and Griffith Taylor (1922). Most, if not all of the existing ice scratched pavements are to be referred to this glaciation, a fact which led to much early confusion and I stress again that cirque erosion and not morainal deposits form the only sure guide to differentiate the various stages.

[NOTE.—Since writing the above I have found a reference by T. B. Moore (1896) to glaciation on the Lyell-Strahan road. This was probably an early observation of the moraine now more fully exposed in the road cutting made in 1937 (see *ante* p. 165). Due credit should be given to Moore for his observation under difficult conditions in 1895.]

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The Age and Physiographical Relationships of some Cainozoic Basalts in Central and Eastern Tasmania

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(Read 14th November, 1938)

PLATES XVII, XVIII

INTRODUCTION

The problems associated with the determination of the age of the Cainozoic volcanic rocks of Tasmania are closely analogous to those presented by similar rocks in Victoria. In Tasmania, as in Victoria, certain volcanic rocks are known to be of pre-Lower Miocene age, while others are known to be post-Lower Miocene from their relationships with fossiliferous marine sediments (Nye and Blake, 1938, pp. 50-51).

More generally, however, in both States the lava-flows are associated with Cainozoic sediments of uncertain age, or directly overlie still older rocks. In such circumstances one must turn to physiographical and petrological evidence in any attempt to determine their age. Both these methods have been applied in Victoria recently with considerable success. It was shown that in Victoria while the lava-flows (mainly basaltic) form two distinct petrological suites corresponding to an Older and a Newer Volcanic Series (Edwards, 1938), neither of these series of rocks was confined to a single geological period of time (Hills, 1938), thus confirming previous opinion. The Older

Volcanic Series was shown to range from the Oligocene into the Lower Miocene, while the Newer Volcanic Series ranged from the Middle Pliocene to the Recent.

It seems highly probable that the Tasmanian lava-flows, which are also mainly basaltic, exhibit somewhat similar age relations, which can be investigated by similar means. As a preliminary step in such an investigation, I recently visited and collected from a number of areas of Cainozoic basalt in Central and Eastern Tasmania. This paper records my conclusions with regard to the physiographical evidence of the age of these basalts.

The Time-Scale Terminology

The time-scale terminology used in this paper is as follows:—By *Cainozoic* is meant what is generally termed in Tasmania, Tertiary and Post-Tertiary. By *Pleistocene* is meant the duration of the Glacial Epoch. For North America and Northern Europe, the Pleistocene, so defined, begins with glaciation on a large scale, and is divisible into two parts, the Glacial Epoch and the Post-Glacial Epoch (Daly, 1934, pp. 14-15). The Post-Glacial Epoch covers what is commonly referred to as the *Recent*.

In Tasmania the Pleistocene is divided into three stages, (1) the Malanna or oldest period of glaciation, (2) the Yolande, and (3) the Margaret or youngest stage (Lewis, 1934). Both the Malanna stage and the Malanna-Yolande interglacial period are thought to have been of much longer duration than the Yolande stage, while the Margaret stage was of shorter duration.

Acknowledgements

I have to thank Dr. A. N. Lewis for reading through the manuscript critically, and generously placing at my disposal his considerable knowledge relating to the problems under discussion. Many of his suggestions have been adopted in the paper.

SOME GENERAL FEATURES OF BASALTIC TERRAINS

Before proceeding to the description of the basalts under discussion, it will be as well to summarize certain concepts which apply to basaltic regions generally, and to Victoria and Tasmania in particular.

Lava fields are of two types:—(1) Confined lava fields and (2) extensive lava fields (Keble, 1918). A confined lava field is one which is confined between the pre-basaltic watersheds: an extensive lava field is one where the lavas have overflowed such watersheds. Both types of lava field occur in Tasmania, but all those to be described here are confined lava fields.

Confined Lava Fields

A confined lava field more or less fills the existing valley, deranging the pre-basaltic drainage. In the inauguration of a new drainage system the location of the new stream is guided by the position of the lines of least resistance to erosion, and by the direction of the gradient. These are frequently combined at the edges of the confined lava field, where the lava-flow and the bedrock are in contact. A pair of *lateral streams* develops, one stream on each side of the lava-flow parallel to the original valley, and to one another, and the original lava-filled valley is left in the position of a ridge. The widening of the lateral valleys gradually restricts the residual volcanic rock, and may completely remove it. Generally an *uncovered residual* can be recognized.

It often happens that a confined lava-flow has failed to fill a valley. In such valleys the deranged drainage might form normal lateral streams, but frequently the major part of the water has meandered across the uneven surface of the lava-flow, incising its course upon the lava field. From this a single stream has developed, with minor laterals as tributaries, and tends to divide the basalt into a number of isolated residuals arranged linearly.

If the basalt does not fill the upper part of the original valley, lake conditions will develop upstream from the basalt barrier until such time as the barrier is breached.

Extensive Lava Fields

In extensive lava fields the lava-flows have infilled the pre-existing valleys, and then covered the interfluves between such valleys, so that the pre-basaltic topography is completely obscured beneath wide lava plains. The variations of gradient over the surface of the lava plain decide the course of any new stream, and by the time such a stream has cut down below the surface of the lava its course is impressed upon it. Such streams have a meandering course, and give little indication of their presence from a distance. Impressed meanders and small hanging valleys developed by intermittently flowing tributaries are characteristic of them. They do not develop large tributaries after they have descended below the plain. Such drainage as would form a tributary finds its own path over the plain, and it will be accidental if it should connect with another stream.

If the gradient of the lava plain does not provide any outlet, swamps or shallow lakes will develop as temporary features until they overflow the rims of the natural lava basins.

Local Complications

The widespread occurence in Tasmania of Mesozoic dolerite, which is more or less equally resistant to erosion as are the Cainozoic basalts, introduces complications rarely met with in Victoria, where the bedrock is almost always more susceptible to erosion than the basalts which overlie it.

Thus, other factors being equal, a basalt flow infilling a valley carved in sediments would give rise to physiographic features very different from those produced by a contemporaneous lava flow in a valley eroded in dolerite. Later stream action would erode the sedimentary interfluves much more rapidly than it would the dolerite interfluves, and the lesser resistance to erosion of the sediments as compared with the basalt would give rise to well defined lateral streams, and leave the basalt as an elevated ridge or line of residuals. In the dolerite valley, on the other hand, the erosion would go on more slowly, either along both sides of the lava field as laterals, or as a single stream, and the lava flow would tend to retain its original appearance longer. The basalt filling the sedimentary valley would accordingly assume a deceptive appearance of greater age unless some other feature provided an independent check. An excellent example of this is provided by the basalts of the Interlaken district and those of the Macquarie River, both of which are discussed later. The contrast between them is brought out very clearly in the geological map of the Midlands (Nye, 1921), in which they appear in juxtaposition.

Another effect of this type of difference in the nature of the walls and floor of the original valley would be that lakes formed upstream from the basalt barriers in sedimentary valleys would tend to have a much shorter life than similar lakes formed in dolerite valleys. Still further complications would be introduced where the valley sides changed from dolerite to sediments or *vice versa* along the course of the infilled valley. This also is illustrated by the basalts of the Macquarie River.

A fourth effect is introduced by the shape of the original valley at the time of the basaltic eruption, particularly for dolerite valleys. In a valley with high steep walls, such as the South Esk, the likelihood of the basalt filling the valley to any great height above its floor would be remote, so that there would be little chance of the reconstituted drainage eroding away the original valley walls. On the other hand, where the original valley was broad and shallow, as at the southern end of Great Lake, the level of the basalt might approach the top of the dolerite valley walls. Lateral valleys would be more likely to develop, and the reconstituted streams might be able to erode away the relatively low dolerite interfluves, and leave the basalt as a low ridge.

All these possibilities need to be kept in mind, therefore, during any attempt to assess the age of Tasmanian basalt flows from their physiographical relationships.

Post-Basaltic Faulting

Allowance must also be made for the varying degree of erosion resulting from the post-basaltic faulting which has caused the elevation of the Central Plateau. Streams on the uplifted block have been rejuvenated, and have transformed their valleys into deep gorges. These gorges are deepest near the fault scarp or scarps (Lewis, pers. comm., indicates that the uplift occurred as a series of step faults), and become progressively shallower upstream towards the interior of the Central Plateau. The Nive River basalts provide an example. At Tarraleah a flow of basalt, infilling the pre-basaltic Nive valley, occurs at a height of about 1000 feet above the valley floor of the present Nive River. At Marlborough, about 10 miles further upstream, however, where the basalt again occurs infilling the valley of the pre-basaltic Nive, the present Nive River flows in a narrow gorge-like valley only 100 or so feet deep, and is still vigorously eroding down into the basalt. These two basalt flows are presumably of the same age, but the Marlborough basalt offers the better basis for estimating their age, since it has not undergone such abnormal erosion as the Tarraleah basalt. Other examples are provided by the basalts of the Bashan Plains, which stand at a height of 1000-1500 feet above the floor of the Ouse Gorge, and probably by the basalts of the Interlaken region.

I. CENTRAL PLATEAU BASALTS

Areas of basalt occur on the Central Plateau of Tasmania near the southern end of the Great Lake, along the Nive River, near Lake Echo, between the Dee and the Kenmere Rivers, and in the vicinity of Lake Sorell and Lake Cresent at Interlaken. Johnston (1888, pp. 217, 249) regarded these basalts as 'marking the close of the Palaeogene period in Tasmania,' i.e. as Miocene in age, and subsequent workers tended to accept this view (Twelvetrees, 1908). Nye (1921, p. 67; 1924, p. 34) suggested, however, that the Interlaken basalts are either contemporaneous with or somewhat older than the basalts of the Macquarie River, which he considers are probably Pliocene. This view is endorsed by Lewis (1927, p. 22) who considers that 'on the Central Plateau glacial features are superimposed on the newer basalts' and further 'that the Yolande glaciation was more recent by a considerable space of time than the eruption of the newer basalts'. (Lewis, 1934, p. 71). The Malanna glaciation he thinks probably occurred after the extrusion of the basalts, although he is not satisfied on this point. Subsequently he has recognized the possibility that the basalts may have been early Pleistocene extrusions (Lewis, 1935, p. 76). Nye and Blake (1938, p. 26), however, now correlate the Interlaken basalts (their 'high level basalts of the Midlands') with the Oligocene basalts of Marrawah. With this I am unable to agree.

(1) *The Great Lake Basalt*

Basalt outcrops over a considerable area at the southern end of the Great Lake, on both the eastern and western sides. On the western side a ridge of this rock extends as a peninsula for three miles into the lake. Along the northern shore of this peninsula are groups of basaltic cliffs (the Beehives) at intervals. The cliffs are of uniform height, from 25-30 feet above water level. Each group of cliffs consists of about half-a-dozen faces of finely columnar basalt, each face projecting outwards so that the cliff face forms a wavy line 'which when viewed from the water resembles a number of beehives' (Legge, 1904, p. 354). The land at the top of the cliffs is flat for some distance, and then slopes gently down towards the table land which stretches westwards to the Ouse Plains. For some miles back from the cliffs this flat surface is thickly strewn with boulders of basalt.

On the eastern side, 'after being submerged opposite the mouth of the Shannon (the outlet of the Great Lake), it appears again towards Todd's Corner at the Battery, and thence extends southwards over the shoulder of Barren Tier' (Lewis, 1933, p. 24).

The total area covered by this basalt flow or flows is about nine miles from W.N.W. to E.S.E., and about four miles in width. Presumably it fills an old valley which debouched towards the Lagoon. The surface of this basalt area, away from the immediate vicinity of the lake, is distinctly youthful. The original flat surface of the flow is still largely retained over the greater part of it. Moreover, at Liaweene a hill of soft scoriaceous basalt, which may represent a centre of eruption, forms a hill about 100 feet above the level of the plain, and is still as high as a dolerite hill of somewhat similar appearance at the junction of the Miena-Marlborough and Miena-Tingara roads (Lewis, pers. comm.).

Both of these features indicate that the basalt is relatively youthful and but little eroded by subsequent glaciation, a fact appreciated by Lewis, who wrote concerning the basalts of this region generally: 'were it not for the conclusive evidence of surrounding districts, I would hesitate to say that these basalt plains had been affected by ice' (Lewis, 1933, p. 26). This youthful appearance precludes the likelihood that the basalts are of pre-Malanna age. However, glaciation appears to have occurred after their extrusion, because the surface of the area occupied by the Lagoon, which is 50 or more feet below the level of the adjacent basalt, is covered by moraine material (Lewis, pers. comm.), and glacial erratics occur along the valley of the Shannon, south of the Shannon Outlet (Lewis, 1934, p. 25). This would indicate that the basalts are interglacial in age, presumably post-Malanna and pre-Yolande, and therefore Pleistocene. There remains some possibility that they are pre-Malanna and of Pliocene age, because the Malanna glaciation may not have affected this part of Tasmania. However, they are much less eroded than the basalt flows at Scottsdale, which are regarded as Upper Pliocene or younger (see below). Also, they have undergone much less erosion than basalts in Victoria, which are correlated as Upper Pliocene from their association with marine sediments (Hills, 1938), but this is perhaps an unsafe analogy.

Origin of the Great Lake

Certain considerations with regard to a possible origin of the Great Lake support this conclusion.

Lewis (1933, p. 23 *et seq.*) has shown that glaciation has played some part in the origin of the northern part of the Great Lake, but under no circumstances could it be called a typical glacial lake. Legge (1904, p. 352) has drawn attention to its extraordinary shallowness, and the level nature of its bottom. It has an area of 60 square miles, with an average depth of only 12 feet (prior to the building of the Miena Dam), and with very few places exceeding 20 feet. On the other hand, the valley of the Shannon, south of the dam, 'shows unmistakable evidence of glaciation' (Lewis, 1934, p. 25). This suggests that glacial erosion played some part in developing the whole of the broad valley in which the lake now lies: but there is no indication that it was responsible for the formation of the lake. The outlet through which it debouches into the Shannon River is cut in basalt and dolerite—not in glacial moraines.

It seems probable, in my opinion, that the Great Lake originated as a result of the outpouring of the basalt about Miena. Lewis (1934, p. 25) suggests that 'it is possible that the Great Lake once drained to the Lagoon, *via* Todd's Corner.' Prior to the basalt outflow there was, as indicated, a valley trending more or less in this direction, into which the broad, shallow valley now occupied by the Great Lake may have drained (assuming that it was formed in pre-basaltic times). As to the origin of this broad valley, no suggestion is offered, but that a correspondingly broad, shallow valley from the north-west joined it at its southern end is clear from the disposition of the basalt.

The outpouring of the basalt lava developed in this north-west valley, probably near Liaweene, and flowed down it, more or less completely filling it, towards the Lagoon. It also probably flowed up the valley now occupied by the Great Lake to some extent, since Legge (1904) describes columnar basalt at water level at Helen's Isle. This may explain the constriction of the lake near this point. The lava flow closed the outlet of the Great Lake valley and dammed back the drainage until it overflowed the basalt and joined the southern lateral stream to the basalt, which is now represented by Swan Bay. Instead of following the course of the pre-basaltic stream to the north of Barren Tier, the dammed up drainage escaped southwards, to the west of it, along the course of the present Shannon River. The outlet of the lake is cut in the dolerite which formed the southern interfluve of the infilled pre-basaltic valley. Presumably the pre-basaltic interfluve was relatively low at this point. That the waters of the lake once extended for a considerable distance over the surface of the basalt prior to the breaching of the dolerite is indicated by the fact that the land at the top of the cliffs at its southern end 'is for miles thickly strewn with basalt stones' (Legge, 1904). The level of the lake must, therefore, have then been at least 30-40 feet higher than it was at the time when the construction of the Miena Dam was commenced. Prior to the building of the dam, it was draining away. The cliffs of basalt along the Beehive Peninsula were probably developed after the breaching of the dolerite outlet. Legge (1904) indicates that the basalt lies on the dolerite almost at water level, and this would render the columnar basalt liable to undercutting, while collapse of the columns would produce cliffs.

Lewis (1933, p. 25) indicates that in the post-basaltic glacial period the whole of the Great Lake valley was filled with an ice sheet. The youthful surface features of the basalt show, however, that the amount of erosion caused by this post-basaltic glaciation was relatively slight and probably added little to the valley structure of the lake. In view of this, the presence of glacial erratics in the Shannon Outlet suggests the possibility that the breaching of the lake had occurred before this period of glaciation developed, rather than that it was brought about by the glaciation. If this is so, the continued existence of the lake confirms the postulate that the basalt flows are relatively young and of Pleistocene age.

Dr. Lewis has wisely counselled caution in accepting this view as to the origin of the lake. He has pointed out (pers. comm.) that a very slight tilting of the Central Plateau block to the north, when it was faulted in post-basaltic times, would have been sufficient to produce the Great Lake. Such a tilt to the north would also have affected the direction of the later consequent streams, and tended to give rise to north-flowing streams or tributaries. More accurate and detailed mapping of the region may establish this, but there is no indication of it on available maps.

(2) *Nive River Basalts*

As indicated above, the valley of the pre-basaltic Nive River is marked by basalt residuals near Tarraleah and at Marlborough. As a result of post-basaltic faulting, and consequent rejuvenation of the river, the Tarraleah basalt now stands at a height of about 1000 feet above the floor of the Nive Gorge. A long spur of dolerite, which divides the Nive from the Derwent, rises for another 200 feet or more on the western side of the basalt, and gives some measures of the pre-basaltic erosion.

About 10 miles upstream is the Marlborough basalt, which extends from the junction of the Pine River with the Nive, down to the confluence of the Clarence River with the Nive. The basalt forms a plain about 10 miles long and about 4 miles wide, with hills of dolerite and Permian limestone on either side. The surface of the plain is distinctly youthful (Pl. xviii, Fig. 2). The Nive now flows in a narrow, gorge-like valley through, and along the edge of, the basalt plain. Being further back from the fault scarp (or scarps), this basalt has undergone much less erosion than the Tarraleah basalt. The valley of the Nive, where the West Coast Road crosses it, is still vigorously cutting down into the basalt. It appears younger than valleys which have been cut in what are presumed to be late Pliocene members of the Newer Volcanic Series of Victoria.

Lewis (1934) has shown that the faulting which affected these basalts was post-Malanna, but pre-Yolande, which fixes the upper limit of age for the basalts as pre-Yolande. The question remains as to whether the basalt is pre- or post-Malanna. The Malanna glaciation extended down to 900 feet above sea-level in the Florentine Valley, immediately south of the junction of the Nive with the Derwent, but the youthful appearance of the Marlborough basalt precludes the possibility of its having suffered intensive glaciation. This suggests that it is post-Malanna, i.e. Pleistocene in age. There remains the possibility, however, that the Malanna glaciation did not extend to this area, and the youthful appearance of the basalts may indicate merely that they are of late Pliocene age.

The basalt infilling the valley of the pre-basaltic Little Pine River is also probably of the same age, since the pre-basaltic Little Pine River was evidently a tributary of the pre-basaltic Nive.

Such large outflows of basalt must have seriously deranged the existing drainage systems, but it is clear from the continued existence of the pre-basaltic interfluves near Tarraleah and Marlborough, that the pre-basaltic valleys were not completely filled by the lavas. Presumably lake conditions would have developed upstream from the lava flow or flows prior to their being breached; and this may have been a contributive, or at least a predisposing, factor in the development of the Ninety-Nine Lagoon region. Since the basalts did not overflow the original interfluves, the rivers returned more or less to their original positions once the basalt barriers were breached. The later fault movements have rejuvenated them, so that they are now actively cutting deep gorges through the basalts and underlying rocks.

(3) *Lake Echo Basalts*

Basalt flows (the Bashan Plains) cap the ridges between Lake Echo and Waddamana (Lewis, 1933, Pl. xiv). The Bashan basalts stand 1000-1500 feet above the Ouse Gorge, resembling in this respect the Tarraleah basalt. From this it is concluded that the Bashan basalt is of pre-Yolande age. The drainage from this area has reformed as twin lateral streams, the Bashan Plains Rivulet and the Boggy Marsh Rivulet, tributaries of the Ouse. Midway along Boggy Marsh Rivulet, between two areas of basalt, is Martin Cash's Marsh, which presumably owes its origin to the influence of the basalt, indicating that the basalt is relatively young.

Several miles to the south of Lake Echo lies the Dee River basalt, which forms a flat-topped ridge between the Dee and the Kenmere Rivers. These two rivers appear to be lateral streams developed more or less at the edges of the lava flow. The infilled valley, which may be called the 'pre-basaltic Dee' valley, drained much the same country as is now drained by the Dee (and is presumably a continuation of the valley in which Lake Echo now lies. Here, as in the Nive River, the damming back of the drainage must have contributed to the formation of lake conditions, and it is a question whether Lake Echo, which is another of these peculiar shallow lakes, rarely more than 20 feet deep in any part (Lewis, 1934, p. 28), did not once extend as far southwards as the northern end of the Dee basalt.

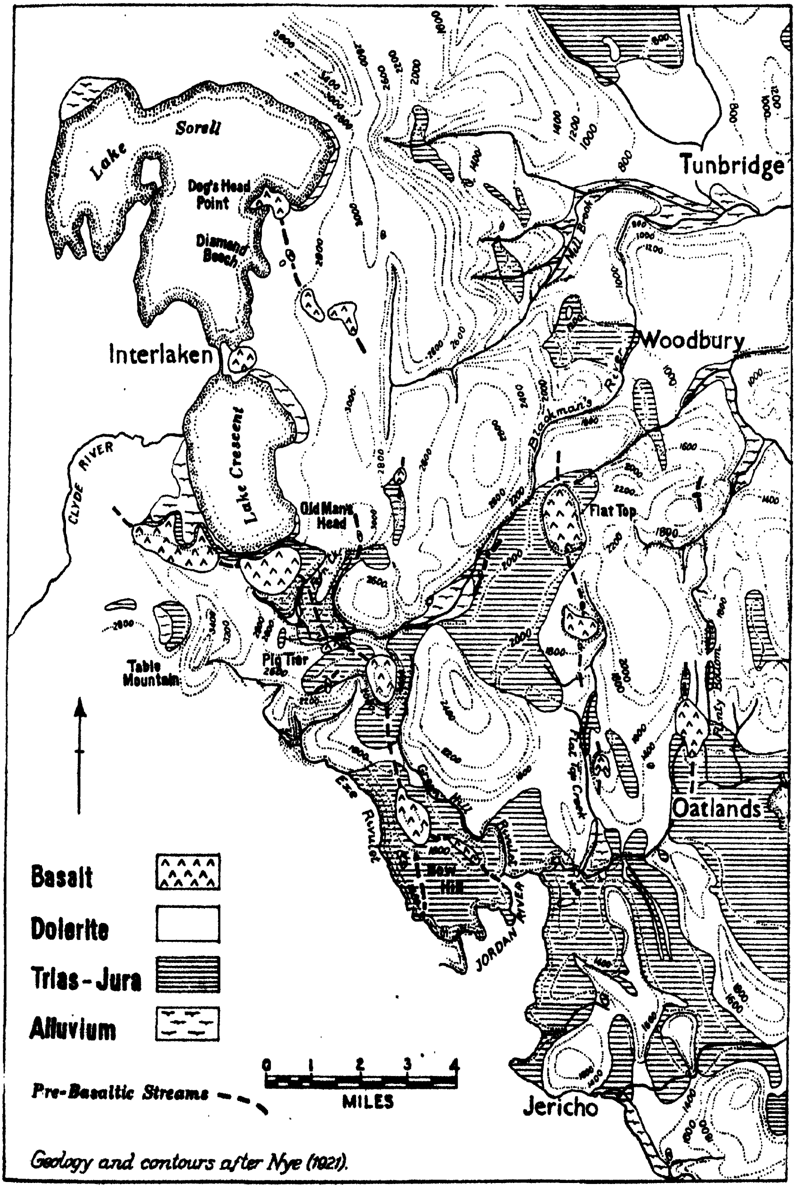

Fig. 1.—Geological Sketch Map showing the distribution of the Interlaken-Jericho basalts and their relation to pre-basaltic stream courses.

Subsequently the basalt barrier was breached by the present Dee River, which, as it cuts vigorously downwards, is causing Lake Echo to recede more and more. Lewis (1934, pp. 27-28) considers that post-basaltic glaciation has contributed to the origin of the Lake Echo valley, so that here again there is evidence that the basalts are proably pre-Yolande. When allowance is made, however, for the fact that they have been subjected to increased erosion as the result of post-basaltic faulting, it seems highly improbable that they could be older than late Pliocene. The continued existence of Martin Cash's Marsh suggests that they are likely to be post-Malanna.

(4) *The Interlaken Basalts*

The basalts in the vicinity of Lake Sorell and Lake Crescent are shown on the geological map of the Midlands (Nye, 1921), on which Text fig. 1 is based. Here again, broad shallow lakes are associated with basalt flows. Lake Sorell is five miles from north to south, and six miles from east to west, and only 13 feet deep in the centre, While Lake Crescent is about 3·5 miles by 2 miles, and only 8 feet deep in the centre (Twelvetrees, 1902, p. 159).

The succession of flat-topped basaltic residuals running south-east from the southern end of Lake Crescent to Bow Hill, each successive residual having its base at a lower elevation, marks the position of a pre-basaltic valley down which the lava flowed. This valley seems to have been a north-westerly continuation of the present Jordan River. The Exe Rivulet has developed as a lateral stream on the south-west side if this lava-filled valley, eroding away the sedimentary interfluve, while the lateral on the north-east side is represented by Fern Creek in the upper reaches, and by Green Hill Rivulet in the lower reaches.

A tributary stream ran due southwards from Flat Top to join this pre-basaltic Jordan, as is shown by the descending level of the bases of the successive basalt residuals in that direction, while another stream flowed southwards from the residual near Flinty Marsh, and a further valley extended from Vincent's Hill *via* Coal Mine Hill towards Andover. Flat Top Creek, Flinty Marsh, Flinty Bottom, and the upper reaches of York Rivulet appear to be lateral streams induced by the filling of these valleys with lava.

It seems probable that the valley now occupied by Lake Crescent and Lake Sorell originally drained into this pre-basaltic river, and the flow of basalt dammed back such drainage, giving rise to, or contributing to, the present lakes. Another stream, now filled with basalt, existed in the vicinity of Dog's Head Point on the eastern shore of Lake Sorell.

A striking feature of the basalt residuals of the pre-basaltic Jordan is that although they are relatively horizontal, considerable differences of elevation exist between successive residuals. For example, there is a difference in elevation of about 800 feet between the base of the residuals near Pig Tier and those at Bow Hills, two miles further 'downstream,' Text Fig. 2. Similarly, the basalt residuals filling the tributaries of the pre-basaltic Jordan are at markedly different elevations. This is well illustrated by Nye (1921, Pl. iii, Sect. EFG).

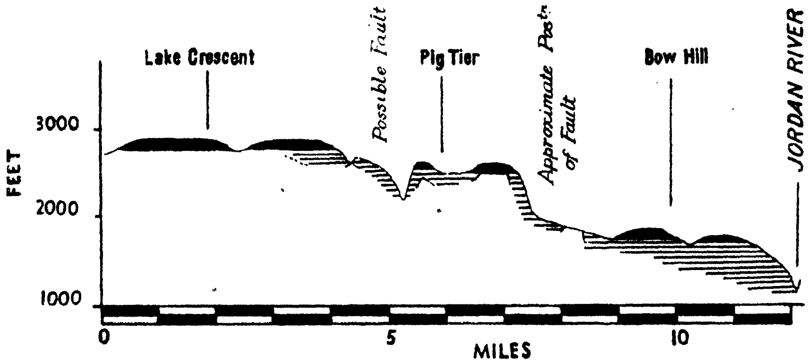

Fig. 2.—Sketch section along the course of the "pre-basaltic Jordan," showing the different levels of the basalt residuals (black).

There can be little doubt, therefore, that the extrusion of the basalts occurred prior to step faulting which uplifted the Central Plateau, despite views to the contrary (Nye, 1921, p. 71). Lewis (1934, p. 20) considers that the valley occupied by the two lakes underwent glaciation during the Pleistocene, so that if the basalts are regarded as responsible for the formation of the lakes, both they and the faulting may be pre-glacial. It seems highly probable that the faulting was more or less contemporaneous with that which affected the basalts further to the west, and that the uplift of the Central Plateau was everywhere pre-Yolande.

The combined effect of the faulting and the infilling of pre-existing valleys by basalt has been to divert much of the drainage into the Clyde River. The waters from Lake Crescent have also found an outlet into the Clyde, round the back of the basalt barrier, and have commenced to drain away. This must have commenced in geologically recent times, because the water level in Lake Sorell is only 2·16 feet higher than that of Lake Crescent (Twelvetrees, 1902, p. 159). The water in Lake Sorell cannot have stood much higher in the past than it does now, because there is no indication that it ever covered the flat-topped basalt residual at Dog's Head Point. This residual now juts out into the lake as a promontory 20-30 feet above the level of the lake, to which it descends abruptly as a result of wave erosion. The two lakes are connected by a shallow channel through a narrow strip of flat land not more than half a mile wide. The small hill of basalt to the east of this may mark an earlier connection between the valleys these lakes occupy.

The flat surfaces of these basalt residuals, as at Dog's Head Point, a feature upon which Twelvetrees commented (Twelvetrees, 1902, p. 160), suggest that the basalts is relatively youthful. Support for this interpretation might be adduced from Twelvetrees' description of the two small areas of basalt about half a mile east of Diamond Beach (Lake Sorell) as lava cones. Of the smaller he says (1902, p. 165): 'The cone . . . is the most perfect survival of a volcanic cone which I know of in the island. No ash or scoriae are to be seen.' Nye, however, doubts whether they are true cones, and thinks they may be merely residuals.

Reference of these basalts to the Pliocene, or possibly to the Pleistocene, runs strongly counter to the views recently expressed by Nye and Blake (1938, p. 26), but, as indicated in the previous section, I think that the deceptively old appearance of these rocks is due not to their being of great age but to the fact that they were extruded in a region which was relatively susceptible to erosion, and which has developed steep gradients as a result of post-basaltic uplift.

II. The Basalts of the Midlands

Certain small residuals of basalt, properly occurring within the Midlands, have already been described in connection with the Interlaken district. The main areas of basalt in the Midlands are the flows in the valleys of the South Esk and the St. Paul's Rivers, extending from Glen Esk Bridge to above Avoca, and the much larger sheet of basalt stretching more or less along the Macquarie River from Conara Junction to south of Tunbridge. Both of these areas are shown in detail on the geological maps of the Tasmanian Geological Survey (Nye, 1921, 1926), and it will help the reader greatly if he refers to these maps in connection with the ensuing discussion.

Occasional exposures show that the basalts overlie lacustrine or fluviatile Tertiary sediments, both in the valleys of the South Esk and St. Paul's Rivers (Nye, 1926, p. 14) and along the southern bank of the Macquarie River (Nye, 1921, p. 50), to a height of 40 feet above the present stream levels. These sands are considered to represent the southern extension of the beds of the Launceston Tertiary basin, which are correlated as Lower to Middle Pliocene by Edgeworth David (1932, Table I, p. 87) and by Nye and Blake (1938, p. 50), who therefore regard the basalts as Upper Pliocene and possibly contemporaneous with the Newer Volcanic Series of Victoria (Nye, 1921, pp. 67-68).

Age of the Tertiary Leaf Beds

Johnston (1874, 1888, p. 268 *et seq.*) divided the sediments of the Launceston Basin into three zones:—

(1) An unfossiliferous upper zone, consisting of drifts;
(2) A middle zone, containing remains of coniferous trees and *Banksias*, and including the basalt flows;
(3) A lower zone containing remains of *Betula*, *Fagus*, and *Cinnamomum*, as well as other leaves.

It is not clear how well defined these zones are; *Banksia* and *Cinnamomum*, &c., occur together in some localities. This division assumes significance, however, in the light of the recent suggestion (Hills, 1938) 'that *Cinnamomum* and other genera belonging to Deane's "brush" type of flora, not now living in Victoria but found in the warmer and moister parts of Australia, serve to indicate (in Victoria) an Oligocene, Miocene, or possibly Lower Pliocene age,' while '"and open forest" flora, from which the above types are absent but which includes *Eucalyptus*, *Banksia*, and *Casuarina*, and other genera now living in the State, indicates a post-Lower Pliocene age.' If this interpretation applies to Tasmania as well as to Victoria, the sediments of the Launceston Tertiary basin may be regarded as ranging from Miocene or Lower Pliocene, in the lower zone, into a post-Lower Pliocene middle zone, while the upper zone may be Upper Pliocene or even Pleistocene. If this is so, the basalts of the Midlands and the North-East, which overlie sands presumed to belong to the Middle Zone of the Launceston Tertiary Basin, should be either Upper Pliocene in age or possibly Pleistocene.

The leaf beds of the Derwent Basin, on the other hand, appear to be mostly Lower Pliocene or earlier, although Baron von Mueller (1884) indicated that the presence of *Alnus* among the leaves suggests a Pliocene age. The basalts overlying these leaf beds are to be regarded, therefore, as Pliocene or younger.

(1) *Basalts of the South Esk and St. Paul's Rivers Valleys*

The South Esk and St. Paul's Rivers were firmly established before the extrusion of the basalts, and had entrenched themselves in valleys 200-300 feet deep, with steeply sloping walls. The basalt flows, which were 30 or more feet thick (Nye, 1926, p. 14), were confined to the valleys and failed to more than thinly cover their floors. As a result, once the basalt barriers were breached the South Esk and St. Paul's Rivers resumed more or less their pre-basaltic courses, cutting new beds along the northern contact of basalt and dolerite. The high dolerite walls and their resistant character have prevented the development of typical 'lateral' streams, so that the basalts have not been left as high-level ridges as was the case with the Interlaken basalts, whose valley walls in large part consisted of softer sediments.

The basalts successfully dammed back the drainage in these two rivers for a period, giving rise to lakes which slowly spread over the basalts until their waters finally escaped over its surface. Evidence of the existence of these lakes is provided by deposits of loose sands overlying the upper reaches of the basalt flows and at the same level as the basalt downstream from them. These sands are described as 'probably Upper Tertiary' (Nye, 1926, p. 15), because 'the basalt is usually regarded as closing the Lower Tertiary period.' However, the surface features of the basalts are far too youthful for this to be the case. It is unlikely that the basalts would have retained their almost flat surfaces if they had been subjected to the erosion of such vigorous streams as the South Esk and St. Paul's Rivers since even early Pliocene times; and it is still more improbable that the coverings of lacustrine sands in their upper reaches would have persisted under these conditions.

The more recent view that they are Upper Pliocene basalts (Nye and Blake, 1938) fits much better with the appearance of the basalts. The possibility must be considered, however, that they may have been extruded during the Pliestocene. The fact that the lakes formed as a result of their extrusion have been drained, while those of the Interlaken area have not, may indicate that the South Esk basalts are the older of the two: but this is more probably due to their different geological setting, which prevented the dispersion of the pre-basaltic drainage into lateral streams.

(2) *The Macquarie River Basalts*

This sheet of basalt forms a long, narrow plain about 24 miles long, and is about 5 miles broad at its widest point, near Campbell Town, with an average thickness of about 100 feet (Nye, 1926, p. 18). The surface of the plain is generally flat, apart from a few mound-like hills which probably represent some of the original points of extrusion. At its southern end it dies out into isolated residuals.

The basalt has infilled the valley and tributary valleys of a river which was as strongly developed as the pre-basaltic South Esk River, and which I shall call the 'pre-basaltic Macquarie' River. At its southern end it appears to have had two main tributaries, of which the eastern is represented by the basalt residuals of Kitty's Rivulet, and the western by the residuals just east of Tunbridge.

The development of the post-basaltic drainage has been of a different character to that of the South Esk, and this difference has arisen from the difference in rock character of the valley walls of the pre-basaltic Macquarie River. The eastern headwater of the pre-basaltic Macquarie had developed entirely in resistant dolerite, and since the basalt did not fill this valley completely, the drainage soon flowed over the basalt without cutting down the original valley walls, just as in the case of the South Esk River. This gave rise to the present Kitty's Rivulet.

The western headwater, on the other hand, had its valley in much less resistant Trias-Jura sediments. The deranged drainage gave rise to a single 'lateral' (the York Rivulet and the lower part of Blackman's River), which eroded the valley sides in preference to the more resistant basalt, and ultimately left the basalt as a series of elevated residuals.

For a distance of 5 miles north of One Tree Hill (i.e. nearly to Ross), the pre-basaltic Macquarie valley had dolerite for its eastern interfluve, and Trias-Jura sediments for its western interfluve. As a result the western lateral—the York Rivulet and the lower part of Blackman's River—developed a valley below the surface of the basalt, and acquired most of the drainage, including the reconstituted Macquarie River and its tributaries. Still nearer to Ross, however, the sedimentary western wall of the pre-basaltic Macquarie changed to dolerite, with the sediments further to the west. This seems to have deflected the western lateral, now the combined Macquarie River and the Blackman's River, to the west of the old valley course. A further tributary comes to this river across the basalt through another, small sedimentary 'gap' to the north of Ross.

A marked feature of the Macquarie River and the York Rivulet is that alluvial flats extend up their courses from where the Macquarie River crossed the dolerite at the south-western end of Mount Augustus to as far south as Tunbridge on the Blackman's River and the York Rivulet, and Glen Morrison and Kitty's Rivulets on the Macquarie River. The probable explanation of this is that as the Macquarie cut down through the Trias-Jura sediments it became superimposed on this dolerite bar, giving rise to slack water or lake conditions upstream, which in turn caused the deposition of alluvium. This alluvium forms a narrow plain whose surface is about 100 feet below the surface of the basalt.

The Elizabeth River which now flows across the basalt plain just south of Campbell Town to join the Macquarie, was also a tributary of the pre-basaltic Macquarie. Its valley is filled with basalt to a height of 1400 feet at the eastern end, the basalt flow culminating in a small hill which was clearly a point of eruption from which a flow issued and helped give rise to the broad plain north-east of Campbell Town. The new Elizabeth River forms the southern lateral of this flow, while Blanchard's Creek, which reaches the Macquarie *via* Conara Junction, forms the northern lateral. As a result, the basalt flow filling the pre-basaltic Elizabeth River has been elevated to a ridge.

In view of the large amount of river erosion which has gone on since their extrusion, the basalts cannot be very young. Two factors have contributed to the apparent youthfulness of the plain between Conara Junction and Campbell Town, namely, the resistant nature of the valley walls which consist of dolerite, and the deflection of the Macquarie

River to the west of the basalt plain, so that only minor streams have affected it. A more accurate estimate of age may be obtained from the residuals near Tunbridge. These are still flat-topped and relatively youthful in appearance (Pl. xvii, Fig. 3). Physiographically they are to be regarded as not older than Upper Pliocene, which is the age assigned to them by Nye on the assumption that both the pre-basaltic and post-basaltic sands at Conara Junction are related to the upper beds of the Launceston Tertiary Basin. On the other hand, a north-south section across the Elizabeth River, east of Campbell Town, suggests that the basalt north of the river lies in a valley eroded in the pre-basaltic sands, which might indicate a time gap between the deposition of these (?) Upper Pliocene beds and the extrusion of the basalts. There is thus a suggestion that these basalts may be of Pleistocene age.

III. THE COAL RIVER AND SORELL BASALTS

(1) *Coal River Basalt*

A basalt flow extends down the valley of the Coal River from Lowdina, north of Campania as far south as Richmond (Nye, 1922). At Lowdina, where the bedrock consists of Trias-Jura sediments, the flow has been eroded to a series of residuals, but further downstream where the bedrock is dolerite it forms a narrow, flat plain, one to two miles wide, and seven to eight miles long. The flow is about 100 feet thick at the northern end, and dwindles to a thickness of about (?) eight feet at its southern extremity near Richmond. It covered the floor of the Coal River valley, but not to a sufficient depth to derange the drainage. The Coal River overflowed the basalt and cut a new channel along its eastern edge. There is no trace of lacustrine deposits upstream from the basalts, although some must have formed. These being deposited on Trias-Jura sediments, would, like the northern extremity of the basalt, have been exposed to relatively greater erosion than the basalt downstream.

The basalt overlies sands which Nye (1922, p. 37) regarded as Lower Tertiary, and now places in the Lower Pliocene (Nye and Blake, 1938); and it is overlain to the south by gravels and conglomerates which Lewis (1935, p. 81) correlates as pre-Malanna (? Pleistocene). The basalts, therefore, are probably of Upper Pliocene age. The youthful appearance of the flow would suggest that it might be younger and Pleistocene, but this youthful appearance is perhaps deceptive. The eroded state of the northern extremity of the flow probably provides a better basis for estimating the age of the flow.

(2) *Sorell Basalts*

Somewhat more extensive flows, with a Trias-Jura bedrock, occur behind Sorell, and to the west of that township, infilling the valleys of former tributaries to the Coal River. These flows give rise to flats which are distinctly youthful in appearance, and cannot be older than Upper Pliocene and are probably contemporaneous with the basalts of the Coal River.

IV. BASALTS OF THE DERWENT VALLEY

(1) *The Upper Derwent*

Basalts occur in the vicinity if Ouse, Hamilton, and Glenora, and are all of relatively young appearance. The largest flow is at Glenora. It overlies Tertiary sediments which contain leaves of *Fagus* and *Cinnamomum* (Johnston, 1888, p. 289), and are therefore presumed to be Lower Pliocene or older. The basalt has infilled a stream which flowed southwards as a tributary to the pre-basaltic Derwent, and also a part of the Derwent valley. The bedrock in this area consist largely of Trias-Jura sediments, which has enabled lateral streams, the Allendale Rivulet and the Belmont Rivulet, to develop on either side of the basalt-filled tributary. In addition, the Derwent developed as a lateral stream on the north-western side of the flow until it breached it near Gretna, and then continued as a lateral along the south-eastern side of the basalt. Similarly, the Styx River, near its confluence with the Derwent, was turned by the basalt, and now flows along the south-western margin of the basalt, converging towards the Derwent. The basalt remains as a flat-topped ridge with steep slopes to the Derwent and the Styx (Pl. xviii, Fig. 1).

The flow just west of Hamilton infills another south-flowing tributary of the pre-basaltic Derwent. The Clyde River has returned to this original valley, partly on the basalt, and partly along its edge. The Ouse basalt infills the lower reaches of the pre-basaltic Kenmere River. The present Kenmere and the Ouse now form the eastern lateral of this flow.

From their appearance, taken in conjunction with their situation in the path of strong rivers which are still vigorously eroding their valleys, these basalts cannot be older than late Pliocene, and are in all probability Pleistocene in age. Presumably, they are contemporaneous with the uplifted basalts of the Central Plateau.

(2) *The Lower Derwent*

Opinions as to the age of the basalts of the Lower Derwent have varied considerably. Johnston (1888) regarded them as Miocene; Allport (1875, 1877) thought them to be Pleistocene, but revised this opinion to Pliocene when they were found to underlie and not overlie the Geilston travertine beds; Noetling (1914) considered them to be Pleistocene, though on somewhat unsound evidence. They are now regarded as Upper Pliocene (Nye and Blake, 1938), although Lewis (1935) has recognized the possibility that they may be Lower Pleistocene.

At several localities they overlie beds containing the *Cinnamomum* flora (e.g. at Geilston, One Tree Point, &c.), while near New Norfolk and Bridgewater they are overlain by gravels which Lewis (1934) correlated as 'immediately pre-Malanna.' This would have established their age definitely as Upper Pliocene, but actually 'the real pre-Malanna gravels at Old Beach, Millbrook Rise, and elsewhere do not overlie the basalts' (Lewis, pers. comm.), so that the basalts may possibly be Pleistocene.

The most extensive of these basalt flows is that stretching from Pontville to Bridgewater. This has been mapped by Nye (1922). It filled the pre-basaltic valley of the Jordan River from its confluence with the Derwent to its original junction with the Bagdad and Strathallern Rivulets, the valley of a tributary which previously flowed eastwards along a dolerite-sediment contact to this point, and the lower reaches of the Bagdad and Strathallern Rivulets. These streams were all ponded until they overflowed and breached the basalt, and it is a question whether the alluvial deposits occuring upstream may not have originated partly in this way. Except in the case of the Jordan River, the valleys of these creeks across the basalt are still narrower than their valleys upstream, so that alluvium may be still depositing. The stronger Jordan River, however, has cut a sufficiently wide valley in the basalt for it to cease depositing alluvium upstream, and appears to be eroding previously deposited alluvium. There is here a suggestion of youthfulness that confirms the youthful appearance of the basalt surface, and supports Lewis's earlier suggestion that these basalts 'may not date further back than the opening of the Pleistocene period' (Lewis, 1935, p. 76).

The basalts outcrops downstream from Bridgewater are presumably of a comparable age. Dr. Lewis has suggested to me that they may be part of one extensive flow (or flows) that continued down the valley of the Derwent from Bridgewater, but are now dissected and submerged beneath the waters of the estuary.

The ridge of basalt extending from Rokeby to Droughty Point probably infills an elevated tributary of this pre-basaltic Derwent. In some occurrences in the Hobart district, however, the basalt has undergone elevation by faulting of uncertain age, and occurs as isolated residuals, as in the vicinity of Cambridge, Kingston, and Margate, and on the summit of Mt. Wellington. The age of these residuals will remain uncertain until the extent and age of the faulting has been ascertained. In close association with these faulted residuals now standing at various elevations are further residuals at sea-level which appear to be of comparable age to the Pontville-Bridgewater basalts.

V. SOME NORTH-EASTERN BASALTS

Observations of the basalts in this part of Tasmania were limited to the flows along St. Patrick's River, at Scottsdale, along the Ringarooma River, and at Weldborough Pass.

(1) *Weldborough Pass*

As indicated by Nye and Blake (1938, p. 26), the small area of basalt outcropping at the top of Weldborough Pass is much older than the other basalt flows of this region, with the probable exception of a small residual of high-level basalt at Bulman Bluff, near Branxholm (Nye, 1925, p. 21). The basalt at Weldborough Pass originally filled a valley in the granite, of Blue Tier, and is presumably a remnant of an old land surface which was eroded away prior to the development of the Launceston Tertiary Basin, so that the basalt is of Miocene or possibly earlier age.

(2) *Basalts of the Ringarooma Valley*

These basalts, on the other hand, are relatively young. Nye and Blake (1938) regard them as post-Miocene and probably Upper Pliocene. Edgeworth David (1932, Table I, p. 87) places them as Werrikooian, since they overlie sands which contain fossil fruits and wood, and are therefore correlated with the sediments of the Launceston Tertiary Basin (presumably the Middle or Upper Zone). The basalt has been mapped in detail by Nye (1925). In the southern part of the area the basalt did not completely fill the pre-basaltic Ringarooma valley. This is shown in a photograph (Pl. xvii, Fig. 1) taken looking south from near the fork of the Branxholm-Ledgerwood and Branxholm-Launceston roads. The youthful, flat surface of the basalt can be seen running back to hills of granite and Lower Palaeozoic sediments in the right middleground. The northward profile of the basalt is equally youthful (Pl. xvii, Fig. 2). North of Branxholm a greater number of flows was extruded, and these seem to have completely filled and somewhat overflowed the pre-basaltic valley. As a result, the post-basaltic Ringarooma River, which established itself on the basalt in the southern part of the area, became the eastern lateral in the northern part, and eroded down the granitic interfluve of the pre-basaltic valley.

The relations of the base of the basalt to the contours on Nye's geological map indicate that the surface of the pre-basaltic sands was more or less flat with a gentle, northerly slope, and that the streams had cut valleys about 50 or more feet deep in these sands, indicating that the estuarine conditions had passed away before the extrusion of the basalts.

Downstream from Herrick it seems probable that the pre-basaltic Tertiary sands completely filled the existing valleys, and even may have covered the interfluves between them. Once the Ringarooma River was established on the eastern margin of the basalt with the bedrock, it probably tended to continue in this position further downstream, getting below the level of the surface of the sands until it became superimposed on the underlying granite well to the east of its pre-basaltic course. The Boobyalla River also seems to have developed as a 'lateral' to the Tertiary sands.

(3) *Scottsdale Basalts*

The large area of basalt in the vicinity of Scottsdale overlies granites and Tertiary gravels in a valley excavated in the granite. The basalt has been considerably eroded, so that it now caps a series of radiating ridges in the floor of the older valley. It appears to be older than the Ringarooma basalts, but this may be due to the fact that the valley in which it lies has always been at a higher level than the Ringarooma valley, since it escaped sedimentation during Lower-Middle Pliocene times. The gravels underlying the basalt are presumably to be correlated with this period, while the basalt is probably Upper Pliocene in age. The pre-basaltic drainage has been dispersed and replaced by the Cox Rivulet and Muddy Creek.

(4) *St. Patrick's River Basalt*

The extent and shape of the St. Patrick's River basalt is shown in a sketch map accompanying the report on the Lisle Goldfield (Twelvetrees, 1908). The youthful appearance of the basalts indicates that they belong to the Upper Pliocene-Pleistocene series of basaltic eruptions, but insufficient time was spent in the area more than to suggest possible explanation of the various physiographic problems associated with these flows.

The basalt has filled the valley of a pre-basaltic stream which flowed southwards from Myrtle Bank, and was, like the St. Patrick's River, a tributary of the North Esk, but joined it much further to the north than does the St Patrick's River. In its lower reaches this pre-basaltic river followed the same course as the Distillery Creek. The more northerly part of the lava flow filled a valley in the Cambro-Ordovician sediments, and the deranged drainage developed as lateral streams, the Patersonia Rivulet and the St. Patrick's River, which have cut down into the bedrock and left the basalt more or less as an elevated ridge. Proceeding downstream, however, the bedrock changes to dolerite, and this deflected the Patersonia Rivulet across the surface of the basalt, causing it to combine with the St. Patrick's River.

Under normal conditions one would expect the St. Patrick's River to continue along the basalt-filled valley, as e.g. the South Esk River does, and Twelvetrees' map suggests that it formerly did so, along what is now Distillery Creek. Some abnormal factor must have intervened to turn the St. Patrick's River southwards across the dolerite wall of the pre-basaltic valley. It is to be noticed that the St. Patrick's River follows a relatively straight course from the place where it leaves the pre-basaltic valley to its present junction with the North Esk River, and it appeared to me, from my very brief observations, that the country immediately east of the St. Patrick's River was at a lower elevation than the country to the west. These two observations lead me to think that either (1) the St. Patrick's River may have been deflected from its former course down the pre-basaltic valley by a post-basaltic fault, or (2) that the bedrock east of the river is composed of sediments and not dolerite, as shown on the Geological Map of Tasmania. Twelvetrees' map is not complete at this point, but he shows a dolerite boundary on the western side of the river.

Another unsolved problem is presented by the right-angled bend in the St. Patrick's River near Myrtle Bank. This may simply be a lateral stream, but the alignment of the basalt residuals in this vicinity, shown in Twelvetrees' map suggests the possibility that there may have been a pre-basaltic stream here which flowed to the north, and formed the headwaters of the pre-basaltic Little Foresters Rivulet. If this were so, the upper part of St. Patrick's Creek was turned southwards by the basaltic barrier.

SUMMARY OF CONCLUSIONS

Study of the physiographic relationships of some Cainozoic basalts of Central and Eastern Tasmania shows that most of these extrusions were confined within pre-existing valleys, and frequently failed to fill the valleys, much less to cover their interfluves. This was particularly so when the pre-basaltic valleys were deep and narrow. The nature of the bedrock has considerably influenced the rate and effects of the post-basaltic erosion. Where the bedrock consisted of sediments, lateral streams have frequently developed, and the basalt has become an elevated ridge or series or residuals. Where the bedrock consisted of resistant dolerite, the post-basaltic drainage has tended to return more or less to its pre-basaltic course, and has not been able to erode away the interfluves to the same degree. As a result, a basalt flow with a sedimentary bedrock may have developed a misleading semblance of greater age in comparison with a basalt flow of similar age on a dolerite bedrock. Further complications are introduced where the character of the bedrock varies along the course of the lava flow, and where post-basaltic faulting has caused rejuvenation of the rivers.

Of the basalts examined, all but one are relatively young extrusions, ranging in age from Upper Pliocene to Middle Pleistocene. The lavas whose age is most readily gauged are those of the Central Plateau, where the basalt flows are associated with distinctive shallow lakes, which may owe their origin, at least in part, to the basalt flows. These basalts have undergone pre-Yolande faulting, so that they cannot be younger than Middle Pleistocene; their youthful features indicate that they cannot be older than late Pliocene, and there is some suggestion that they are post-Malanna.

In the Derwent valley equally youthful-looking basalts overlie Tertiary beds containing the *Cinnamomum* flora, and are overlain by gravels which may be pre-Malanna or younger. Recent studies have indicated that in Victoria the *Cinnamomum* flora may range from Oligocene to Lower Pliocene. The upward gradation of this flora in the Launceston Tertiary Basin to a flora tentatively regarded as post-Lower Pliocene in Victoria may indicate that the basalts in the Midlands, which overlie the Launceston Tertiary beds, are not older than Upper Pliocene. The degree of preservation of the basalt surface suggests that they may be still younger.

Of the north-eastern areas examined, little can be added to the conclusions of previous workers. The youthful appearance of the basalt surfaces suggests that they are of Upper Pliocene to Pleistocene age. The basalt at Scottsdale appears to be somewhat older than that at Ringarooma and Branxholm, and if the Scottsdale basalt is regarded as Upper Pliocene, the Ringarooma basalts may well be Pleistocene. It seems probable that intermittent extrusions occurred in different parts of the State throughout Upper Pliocene and Pleistocene times.

Only one area of basalt among those examined, that at the top of Weldborough Pass, appears to be older than Upper Pliocene. This basalt, like the high-level basalt at Bulman's Bluff near Branxholm, is a residual from a pre-Pliocene landscape, so that it is of Miocene or earlier age and may tentatively be correlated with the pre-Lower Miocene basalts of North-Western Tasmania. The high-level basalts of the Midlands, on the other hand, have been shown to belong not to this early period, as has been suggested, but to the (?) Pleistocene extrusions of the Central Plateau. The apparent age of these basalts is the outcome of the special susceptibility of their environment to erosion.

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PLATE XVII

FIG. 1.—Branxholm: Basalt-filled valley, looking south from near the fork of the Branxholm-Ledgerwood and Branxholm-Launceston roads. The youthful, flat surface of the basalt can be seen running back to hills of granite and Lower Palaeozoic sediments in the right middleground.

FIG. 2.—Branxholm: The northward profile of the basalt is equally youthful. (Same locality as Fig. 1.)

FIG. 3.—Tunbridge: Showing the youthful profile of the basalt residuals east of Tunbridge outlined against dolerite hills in the background.

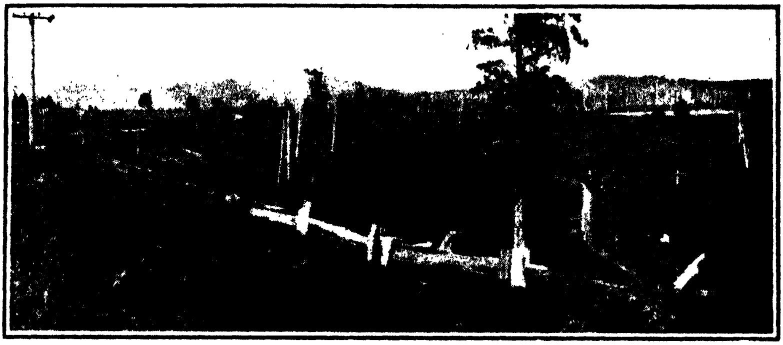

Fig. 1.

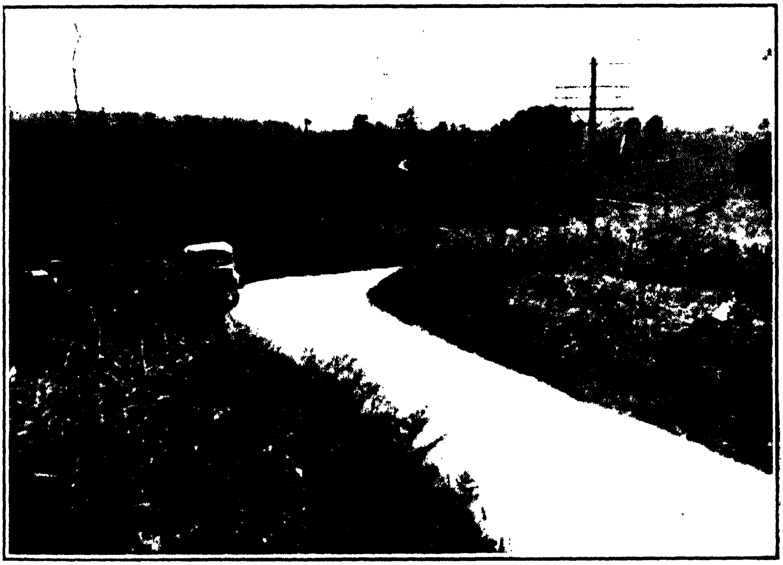

Fig. 2.

Fig. 3.

PLATE XVIII

FIG. 1.- Macquarie Plains Railway Station: Showing the youthful profile of the Glenora basalt (on the right) viewed across the Derwent. The hills in the left middleground and the background consist of dolerite and Palaeozoic sediments.

FIG. 2.—Marlborough: View across the youthful valley of the Nive (marked by the line of trees) from the West Coast Road, looking E.S.E.

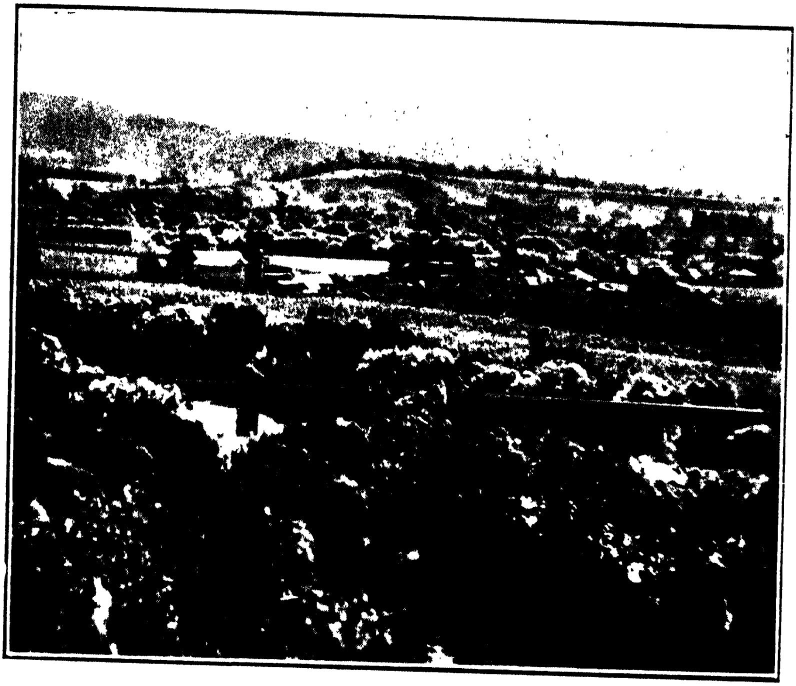

Fig. 1.

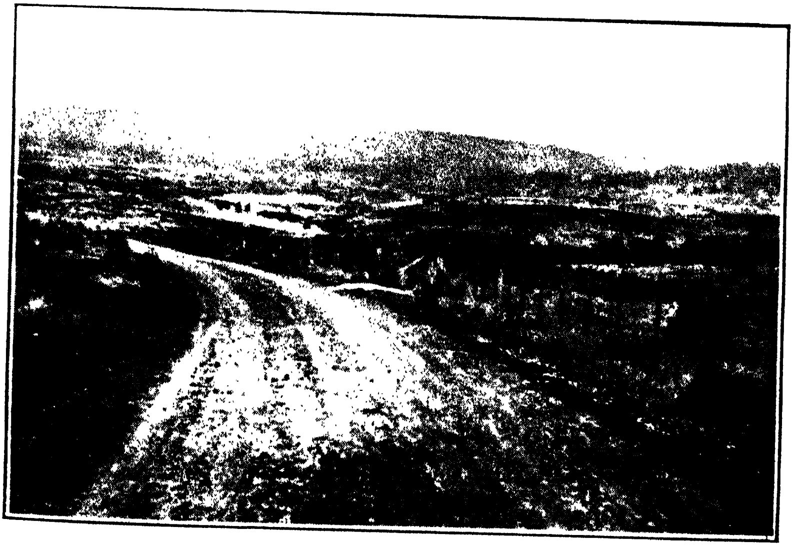

Fig. 2.

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The Soils and General Ecology of the North-East Coastal Regions of Tasmania

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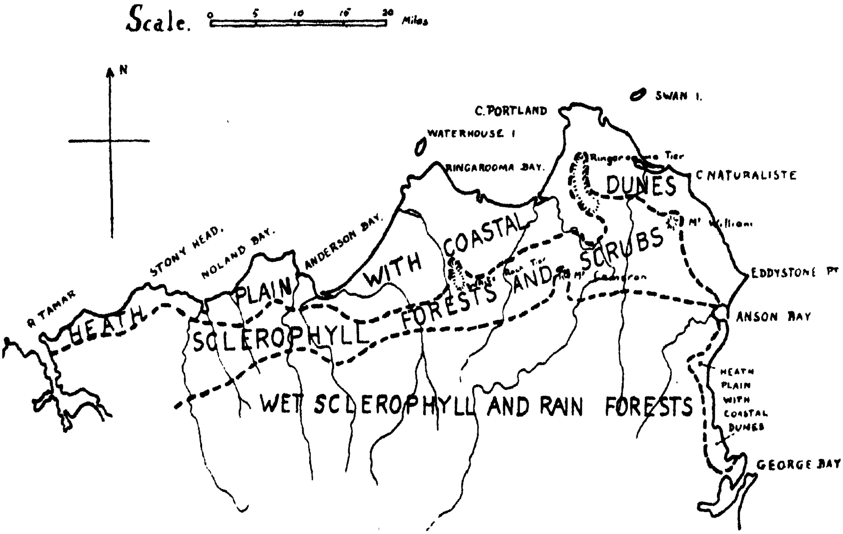
PLATE XIX

(Read 14th November, 1938)

Recently an examination of the north-east coastal zone of Tasmania was made by means of some fourteen traverses across the area. These traverses were made following a detailed investigation of the soils and vegetation of approximately 7500 acres at Curries River and Stony Head some six to nine miles from Lefroy. This survey was undertaken at the request of the Department of Agriculture of Tasmania prior to a projected scheme of land development, and the extension of the investigation reported here was carried out for the purpose of determining the area and distribution of similar country in the north-east, to find to what extent the Curries River area is typical of the whole, and to assess generally the agricultural possibilities of the coastal strip.

Topographically the north-east coast, which embraces the coastal lands from the mouth of the River Tamar to George Bay on the east coast, presents a simple arrangement of features frequently associated with relatively low coastlines, namely, a belt of dunes fringing the sea shore, a well-marked trough behind the dunes, with the usual swamps and lagoons therein, and then more or less gradually rising country intermediate between the coastal features and the more hilly and mountainous areas farther inland. Apart from Mt. Cameron, White Rock Tier, Ringarooma Tier and Mt. William, and certain rocky bluffs and capes on the coastline there are few prominent features of any great topographical significance in the coastal belt or adjoining rising country.

Superimposed upon the above simple topographical arrangement is an equally simple arrangement of soils and vegetation. This is shown on the accompanying sketch map where the dunes, the dune trough, and the gently rising country occupy the zone marked as *heath plain with coastal dunes.* Farther inland from this and occupying slightly hilly to hilly country is a zone of *sclerophyll forests and scrubs*, and still farther inland occupying the more hilly and mountainous areas a zone of *wet sclerophyll and rain forests.* It is with the first two zones that this investigation is concerned.



Vegetation Zones, North-East Coast of Tasmania.

In the first zone the dunes and adjacent lagoons and swamps are of recent origin whereas the intermediate rising plain country consists of pleistocene and pliocene sands with some swamps and heavy soil flats. Farther inland, occupying the second zone and with some outcrops in the coastal area, are cambro-ordivician slates and schists, granite, and dolerite and basalt as intrusives. The granite is more common in the eastern half of the area.

The sand dunes of the coastline vary, in their unbroken state, up to fifteen chains wide. Often they are considerably broken, the landward edge of the dunes being quite serrated, the direction of the teeth being away from the prevailing westerly wind. Frequently the sand reaches much farther than a mile inland. Where the dune sand has been completely blown away there is often exposed old soil profiles and hardpans in various stages of destruction. These are apparently the remains of the soil type profile now characteristic of the heath plain country. The soil profile of the consolidated dunes consists of a very variable depth of sand with organic matter accumulation over deep yellow calcareous sand. Frequently old surface horizons are encountered in the profile. Plate XIX, fig. 1, shows partially broken dune with the trough beyond.

On the seaward side the dunes have a low cover of *Spinifex hirsutus, Juncus maritimus, Poa caespitosa, Acena sanguisorba, Heleocharis acuta,* with a little *Danthonia* and occasionally other grasses. There are isolated windswept specimens of *Leucopogon richei, Bursaria spinosa,* and *Cassineia aculeata.* On the sheltered side the vegetation is of much larger habit and denser growth, the chief species, apart from those listed above, being *Acacia sophorae, Banksia marginata,* and *Pteris aquilina,* with very occasional specimens of *Eucalyptus viminalis, E. amygdalina, Leptospermum* spp. and a number of species of the Restiaceae.

The soils of the coastal trough vary from true deep peaty swamps to deep wet sands with variable accumulation of organic matter. Elongated sheets of water are frequent and the vegetation varies considerably. It is, however, significantly the most naturally grassy area in the coastal zone, the two commonest species being *Themeda forskalii* and *Danthonia penicillata.* Other common species listed were *Xerotes* spp., *Lepidosperma elatior Diplarrhena Moraea,* and many species of the Restiaceae and Juncaceae. *Acaena sanguisorba, Hibbertia angustifolia* and *Pimelea glauca* were more restricted in their distribution, with a few localities in which the latter was dominant or nearly so.

The gently rising land intermediate between the above features and the inland soils occupies the greatest portion of the coastal zone, and it was primarily to estimate the possibilities of this area that this study was undertaken. The greater part of this gently sloping country is occupied by a humus podsol soil type which is distinguished by an acid reaction, and waterlogging in the wetter months of the year. The soil profile consists of about one foot of dark grey sand with accumulation of coarse organic matter over a depth of light grey sand, beneath which, and commencing at about 30 inches lies a black and brown organic hardpan frequently more than a foot thick. Beneath the pan lies a considerable depth of light grey sand. Analytical data for this soil type are included in the table given as an appendix to this paper.

This soil type represents one of the poorest phases of podsolic soil developed in Tasmania and is characterized by a dominant heath vegetation (Plate XIX, fig. 2) whose principal components are a large number of species of the Epacridaceae, the genera of most frequent occurrence being *Epacris* and *Leucopogon.*

There is also present a large number of smaller plants belonging to the order Leguminosae, the commonest being *Gompholobium huegelii* and *Kennedya prostrata.* The species of larger habit are represented by *Leptospermum scoparium, Melaleuca squarrosa, M. gibbosa, Acacia verticillata, Xanthorrhaea australis, Banksia marginata,* very stunted *Casuarina distyla,* and *Eucalyptus amygdalina.* Of occasional occurence is *Xerotes longifolia.* The presence and habit of the Eucalypt seemed to be determined by the degree of shelter from the wind. In clearly windswept localities it was totally absent, in slightly sheltered situations it was stunted and bent over at considerable angles, and in generally sheltered situations it attained its normal development. All three phases were noted on the humus podsol soil type.

Also in the zone of the humus podsol occur limited areas of three soil types related to the humus podsol and a limited acreage of heavy soil flats with variable profile. Analytical data on a profile from two of the sub-types typified by a marked dominance of *Xerotes longifolia* and by *Pimelea glauca* and on a profile from a heavy flat are contained in the table at the end.

In the sclerophyll forest and scrub zone the soils are more normally developed podsols residual on the rocks of their origin. There is some variation in the texture of the surface soil from sand to silty loam similar to that exhibited by such soils elsewhere in Tasmania. The subsoil consists of yellow and grey mottled clay. In the soils derived from granite there is a marked presence of grit throughout the profile. Other minor variations noted were the presence of a small quantity of ironstone gravel in the subsurface horizons and occasionally a slight induration of the same horizon.

The vegetation on these soils, illustrated in Plate XIX, fig. 3, consists principally of a sclerophyll forest of *Eucalyptus viminalis* and *E. amygdalina* with *E. sieberiana* on the gritty soils derived from granite. Other large species of common occurrence are *Acacia* spp., *Casuarina* spp., *Exocarpus cupressiformis, Banksia marginata, Leptospermum* spp. and *Melaleuca* spp., with an underscrub of numerous species which varied considerably with such conditions as soil drainage, topography and profile differences. The chief vegetation classes developed were the dominance of heath on very sandy soils, the dominance of *Xerotes* and grasses on the sandy loams and silty loams where the drainage was good, and the development of scrubs of *Leptospermum* and *Melaleuca* where the drainage was poor.

The zone occupied by the heath plain and coastal dunes is at present utilized for grazing sheep, the carrying capacity varying from 10 to 20 acres for one sheep. Owing to their ready destruction and consequent blowing the dunes should be excluded from any plan of utilization. The swamps of the dune trough and the heavy flats are obvious sites for development but, though numerous, they aggregate only a small percentage of the total area. Similarly, the better phases of the heath plain characterized by a less heathy vegetation are possible of development with subterranean clover but they represent only a small percentage of the area occupied by the humus podsol. The normal and extensive phase of this soil, although carrying only a light and therefore easily cleared vegetation, is a very poor soil and except for the Naracoopa sand* of King Island no pastures of any value have been seen on similar soils elsewhere in the State. On the Naracoopa sand, which is a slightly better soil with a dominant braken vegetation, subterranean clover pastures take about six years to rise to full production. The sclerophyll forest and scrub area is characterized by soils which are growing good subterranean clover pastures in numerous localities elsewhere in the State.

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* Stephens, C. G., and Hosking, J. S. A Soil Survey of King Island. *C.S.I.R. Bull.* No. 70.

APPENDIX

Soil and Vegetation Type.	Heath Plain with Humus Podsols.															Heavy Flat Soil.		Sclerophyll Forest Podsol.					
	Normal Type.					Sub Type 1.					Sub Type 2.												
Soil Number	5412	5413	5414	5415	5416	5417	5418	5419	5420	5421	5432	5433	5434	5435	5436	5437	5438	5426	5427	5428	5429	5430	5431
Horizon	A1	A2	A3	B1	B2	A1	A2	A3	B1	B2	A1	A2	B1	B2	B3	A1	A2	A1	A2	B1	B2	B3	B4
Depth in Inches	0-5	5-11	11-24	24-27	27-36	0-9	9-21	21-38	38-48	48-69	0-4	4-19	19-22	22-23	33-48	0-2	2-11	0-1	1-4	4-8	8-11	11-24	24-36
Per Cent.																							
Coarse Sand	56.0	64.3	62.0	60.9	55.2	47.0	54.1	51.6	51.9	58.0	52.0	64.0	59.7	41.2	43.8	4.3	11.7	19.7	26.7	29.0	28.5	15.4	16.8
Fine Sand	32.1	31.6	35.2	24.7	29.6	45.0	39.2	42.7	38.6	36.3	33.7	27.7	18.3	15.6	14.5	12.7	22.7	43.5	47.9	47.3	42.5	26.3	28.5
Silt	3.8	1.7	1.8	6.4	2.5	3.2	2.6	3.1	2.4	1.7	6.0	5.2	14.1	5.3	5.7	21.0	14.3	15.5	17.7	20.1	21.6	14.3	16.3
Clay	2.4	3.3	1.4	5.4	8.8	2.8	2.8	2.4	5.6	3.7	3.7	2.1	7.8	34.6	33.1	31.3	39.9	5.3	3.2	3.2	12.4	41.2	37.2
Loss on Acid Treatment	0.3	0.0	0.0	1.2	1.5	0.6	0.3	0.2	0.7	0.3	0.5	0.1	0.2	0.8	0.9	2.3	1.8	0.9	0.4	0.2	0.7	0.8	0.7
Moisture	1.1	0.2	0.1	0.7	1.9	0.6	0.3	0.2	0.7	0.4	0.7	0.1	0.6	3.6	3.7	7.2	4.6	2.5	0.9	0.3	0.3	2.3	1.8
Loss on Ignition	5.9	1.4	0.5	2.2	3.2	2.4	1.1	0.6	1.9	1.0	3.6	0.4	0.2	3.9	2.5	22.0	10.1	14.7	5.1	1.0	1.0	5.4	4.2
% P_2O_5 } Hydrochloric	0.007	—	0.002	—	—	0.014	—	—	—	—	0.010	—	—	0.006	—	0.057	0.017	0.025	0.010	—	—	—	—
% K_2O } Acid Extract	0.033	—	0.028	—	—	0.018	—	—	—	—	0.388	—	—	0.219	—	0.438	0.498	0.106	0.072	—	—	—	—
Reaction pH	5.7	5.4	5.8	5.3	5.2	8.2	7.9	7.8	7.6	7.2	6.3	6.5	6.9	7.0	6.8	6.5	7.0	5.6	5.1	5.7	5.8	6.3	7.7

FIG. 1.

FIG. 2.

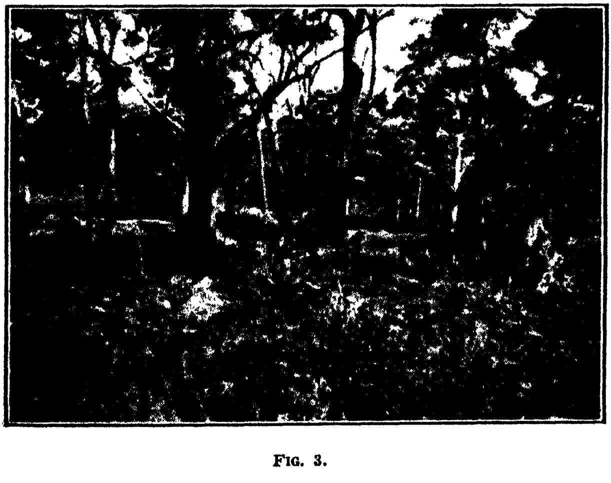

FIG. 3.

PAP. & PROC. ROY. SOC. TASMANIA, 1938 (24TH MAY, 1939)

Notes on the Habits of the Extinct Tasmanian Race

No. 4:—On the Discovery of Tasmanian Aboriginal Remains at Mt. Dromedary, Tasmania

By

W. E. L. H. CROWTHER

(Read 14th November, 1938.)

In September, 1938, a small group of human bones was discovered by N. Johnson, whilst looking for birds' nests in a sandstone cliff, at Mt. Dromedary. An incomplete cranium, forwarded to the Tasmanian Museum was recognized as being almost certainly that of a Tasmanian aboriginal.

A police inquiry being necessary, a visit was made to the locality by the writer, accompanied by Dr. Pearson and Mr. Whittle of the Police Department.

On the northern face of Mt. Dromedary is a deep valley running downwards in a north-west direction towards the Back River. Here, at an elevation of 1475 feet, is a bold sandstone scarp in the face of which is a series of sandstone shelters known locally as Martin Cash's Caves. Cash, the well-known bushranger, hid for a time in this area about 1840, and it is possible that he and his gang actually occupied these shelters.

At the site where the bones were found, the scarp slightly overhangs the base, and there are several recesses, which, although not actually caves, give shelter from all weather except from the north-west and north. The sandstone itself is soft and deeply fretted in places, resembling lace-work, and there is a general tendency for the stone to weather rapidly. The bones were found in a shallow recess about 12 feet above the base of the scarp.

The recess was little more than a shelf, about 6 feet each way and inclined downward and forward. At the time of our visit the human bones had been removed to ground level, but scattered in cracks and inequalities of the shelter were remains of birds and small marsupials principally the ring-tailed opossum.

There was no evidence that the human remains had been wrapped or preserved.

DESCRIPTION OF THE BONES

The bones were as follows:—

(1) The facial portion of the cranium.
(2) The right *os innominatum* (incomplete).
(3) The left *os innominatum* (incomplete).
(4) Two pieces of the left femur.

The Cranium

This comprised the facial portion consisting of the frontal bone, right and left malars and maxillae, all in excellent preservation. The orbital areas showed the Tasmanian characters being low and quadrilateral in shape. These were not, however, as marked as in a fully developed skull, nor did the superior margin project beyond the lower.

The dentition was not complete, and many of the teeth were missing. The 1st molar (right) and 2nd pre-molar (left) had been broken at the alveolar margin—only the 2nd molar (right) and the 1st and 2nd molar (left) were *in situ* and complete. The non-erupted 3rd molars of both sides were missing.

Ossa Innominata

Both right and left halves were defective in regard to much of their iliac and pubic portions, but the ischial areas were more complete. The right acetabulum was nearly complete, but that of the left side lacked the pubic portion. The acetabular cavities were not completely ossified, the lines of the bony sutures being still well marked.

The Left Femur

Two fragments, an upper comprising the head, neck, and portion of the great trochanter, and the lower epiphysis complete. The upper portion had separated into two parts, probably as a result of handling since the discovery, the head having come away from the neck. The head does not, however overlap the neck when fitted back into position, pointing to ossification not having been complete.

From the foregoing it may be concluded that the skeletal remains are from the one individual, an immature Tasmanian aboriginal. The characters of the sutures and dentition of the cranium indicate an age of 16-17 years, possibly less.

The racial characters, while not so strongly marked as in an adult skull, are definitely Tasmanian. The weight and size of the bones (especially those of the pelvis) point to their being those of a female. None of the bones show signs of attempt at incineration or damage from teeth of carnivorous animals.

THE METHOD OF DISPOSAL OF THE DEAD

The methods by which the extinct Tasmanians disposed of their dead have been summarized by Ling Roth (1899). Instances of disposal of individual bodies have been described by Péron (1807, p. 265), Calder (1875. p. 27), Pulleine (1924, p. 83), and Crowther (1934, p. 22). In some cases the body was bound in a strongly-flexed position and was usually either incinerated or left in a hollow tree. The position of flexion was not attempted in all cases, and many remains have been discovered in sand-dunes and elsewhere that appear to have been simply left where they died without any attempt at systematic disposal. Many observers speak of the wide-spread habit of the Tasmanians of wearing bones of their relatives, either suspended around their neck or carried in receptacles. Pulleine (*ibid*) describes a case in which the remains were contained in a skin bag which were found in a recess in a sandstone scarp high up on the shoulder of Mt. Nicholas, a discovery very comparable in site and nature to that described on Mt. Dromedary.

It may be concluded that the remains found at the latter site are those of an immature Tasmanian aboriginal placed there by a relative in accordance with the accepted custom of the race.

Acknowledgements

Thanks are due to Mr. Hedley Johnson who discovered the bones; to his mother, Mrs. I. Johnson of Upper Dromedary, who was instrumental in placing them at the disposal of the Tasmanian Museum; and to the Police Department, for assistance in regard to the investigation.

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PAP. & PROC. ROY. SOC. TASMANIA, 1938 (24TH MAY, 1939)

The Development of the Guano Trade from Hobart Town in the Fifties and Sixties

By

W. E. L. H. CROWTHER

(Read 14th November, 1938)

Within recent years there has been a marked return of interest in the remote islands of the Pacific, since these islands have now acquired a strategic value on account of the Empire and Pan-American Flying Routes. In the following pages an attempt has been made to link up their history with the development of the guano industry from Hobart Town by the ships employed by the late Hon. W. L. Crowther, F.R.C.S., C.M.Z.S. in his whaling and timber interests.

ISLANDS ADJACENT TO TASMANIA

Lawrence Rocks—
Mt. Chappel Island—
Breaksea Island—

The Lawrence Islands, near Portland, Bass Strait, were the first exploited. Here in 1854 the little ships *Union*, *Flying Squirrel*, and *Scotia* were employed taking guano, which was sold at Hobart Town at £8 per ton.

A report ('Hobart Town Advertiser', 6th April, 1854) states that there was a great quantity of guano, which was filled into bags and so loaded into open boats, from a platform about 18 feet above a rocky ledge. Upon this latter the stern of the boat was grounded, the remainder being afloat in deep water and often exposed to a heavy swell. Such a method of loading must have been dangerous and wearing to both men and boats.

A lease of Mt. Chappel Island, in order to take guano, was applied for by W. L. Crowther from the Government of Tasmania. He was not alone in the field, however, as a Mr. Askunas of Melbourne, having purchased information as to the presence of guano there, approached the Government with the same request, offering a rental of £500 a year for four years. The Minister concerned, believing the guano to be of immense value, decided to suspend the Waste Lands Act, under which the application for the lease had been made, and refused Crowther's offer. In no way discouraged, the latter landed his working parties on the Island and commenced to bag up the guano for shipment.

Askunas acted promptly and chartered a vessel, the *Boomerang*, at Melbourne to proceed to the Island. On landing, her crew were set upon and driven back to their ship which returned to Queenscliff. Heavily reinforced, the *Boomerang* returned to Mt. Chappel. One man dressed as a constable read a document with an imposing seal (it was stated after in evidence that it came from a pickle bottle), which claimed to give the newcomer legal possession. As a result of this stratagem or of superior force, Crowther's party withdrew to their boats, when the *Boomerang's* crew completed the filling of the bags, and, with the guano already procured, loaded their ship and left for Melbourne.

In an action Crowther *v*. Askunas held at Hobart ('Mercury', September 18th, 1861), the plaintiff was not successful. His contention that to be in possession was equivalent to a title, not being sustained.

In a long letter to the same paper (August 1st, 1861) Crowther pointed out that the deposits were of a very limited extent. He warned farmers and the public that, except for 300 tons of pure guano at the site of a cormorant rookery, all of which had been removed by the *Boomerang*, no deposits existed elsewhere on the Bass Strait Islands. He gave an analysis of an extensive deposit immediately below the surface on Mt. Chappel, which was principally carbonate of lime, and valuable phosphates being present only in traces.

An account of this controversy with the Government as to the Bass Strait islands is given in considerable detail in Tasmanian Parliament Paper No. 38 (1861). The matter, however, settled itself when it was realised that, except for an odd deposit at a site of a rookery, guano in commercial quantities did not exist. It is of interest to note that among the leases applied for by Mr. Askunas was that of Cat Island, on which the preservation of the gannet rookery is a matter of Government interest at the present time.

Crowther made one more effort, this time from Breaksea Island near Port Davey. From this site a cargo was obtained by his whalers, and his ship the *Juno* was loaded and despatched to Ipswich, England. When analyzed on arrival, it was found that the cargo was only a light sandy soil almost without fertilizing properties. His heavy loss convinced him that guano had to be found in dry tropical or sub-tropical climate, and he sent his whalers to make a systematic search for suitable islands in such latitudes.

ISLANDS IN THE CORAL SEA

Wreck Reef and Islets	22. 10. 30. S. Lat. 155. 28. 40. E. Long.
Bell Cay, Swaines Reef	21. 42. S. Lat. 151. 20. E. Long.
Raine Island	11. 35. 50. S. Lat. 144. 2. 20. E. Long.
Bramble Cay	9. 7. 50. S. Lat. 143. 52. 10. E. Long.
Brampton Shoal and Islets	18. 49. 19. 35. S. Lat. 158. 2. 6. 185. 4. 3. E. Long.
Pilgrim Island	24° S. Lat. 104° W. Long.
Lady Elliot's Island	6. 6. S. Lat. 152. 40. W. Long.

The Coral Sea may be regarded as that area lying between the coast of Queensland and Noumea on the one hand and New Guinea and Norfolk Island on the other. The visits of Crowther's own whalers to this region must have made him familiar with the existence of islands and reefs supporting the rookeries of innumerable sea birds.

Personal contact with the officers of H.M.S. *Fly* and *Bramble* when refitting at Hobart Town after surveying these seas strengthened his intention to lease and work certain reefs and islands. To this end, with another (? E. I. Chapman) he formed the Anglo-Australian Guano Company early in 1861. On March 4th of that year a schooner, the *Harp*, was chartered and cleared in ballast for Guam. To clear for Guam was a common custom at this time when an owner did not wish to disclose the destination of his vessel. News, however, was received on July 5th that the *Harp* had been wrecked on Bird Island, fortunately without loss of life.

Bird Island which is part of Wreck Reef is low, about one mile in circumference, and surrounded, except in one part, by a coral reef. The anchorage is very unsafe and cannot be used by shipping during the hurricane season. Here Flinders' ship, the *Porpoise*, was lost in 1802.

Several Tasmanian vessels were lost in this vicinity in succeeding years, and a list of them is given in Appendix A. At this period gold had been discovered in Gabriel's Gully near Otago, New Zealand, and, to convey diggers and supplies to that port my grandfather had called in two of his whalers, the *Isabella* and *Flying Squirrel*, and opened up a regular shipping service between Hobart Town and Dunedin.

On June 6th, 1862, the little schooner *Flying Squirrel* (79 tons) left Dunedin for the 'Polynesian Group,' where she took in 100 tons of guano, returning with it to Hobart Town, whence she sailed on September 16th for Dunedin with timber from Crowther's mills at Oyster Cove.

By January 10th, 1863, the secret and details of the new venture were widely known, as a despatch from the Secretary of State, dated October 27th, 1862, confirmed the action of H.M. Government in granting to the Company an exclusive occupation for a term of years of certain guano islands in the South Pacific area. The islands and their locations are given above. The lease was to be for seven years in each case, and authority was given to erect buildings, &c., on the islands. Instructions as to maintenance of the personnel and their discipline also were laid down. This agreement also provided that a statement should be made each half year of vessels lifting guano and the total tonnage taken. Royalties were to be paid at the rate of 2s. per ton of guano for the first two years, and at the rate of 4s. per ton for the remaining five years. Such a concession aroused great interest at Hobart Town, and the 'Mercury' four days later commented in a very laudatory manner on the enterprise of their fellow citizen.

Dr. Crowther's largest whaler, the *Offley*, was called in and fitted to take guano whilst whaling on the out and home passages. A schooner, the *Northern Lights*, was purchased to engage in the trade.

An interesting legal position arose on March 13th, 1863, when the *Offley* was refused a clearance by the Customs Department. It was contended that, although as a whaler she had exemption from light and port dues, this exemption did not cover the carrying of guano. The sum claimed, £15 13s. 4., was paid under protest the next day, but recovered with costs as a result of legal action taken some weeks later.

Some dislocation of Crowther's fleet was caused by the outbreak of the Maori War. The *Isabella*, having been chartered to convey troops to New Zealand, was refitted for that purpose. On August 16th, 1863, she sailed from Hobart Town with seven officers and 110 other ranks of the 12th and 40th Regiments. Another whaler, the *Sapphire*, was called in from the whaling grounds and laid on for Bird Island, whence she arrived on December 14th with 320 tons of guano.

So far all seemed well with the industry. Guano was coming in freely by Crowther's ships, and by at least one chartered vessel, the *Daniel Watson*, and there was a ready market established in Tasmania as well as at Melbourne, Adelaide, and as far as New Zealand. The time seemed ripe to extend the venture.

On April 16th, 1864, Mackay's launched for Crowther a schooner called by (his wife's) name, *Marie Louise*. The new vessel of 50 tons, rigged as a fore-and-aft schooner, was designed to explore the Pacific Ocean for new guano deposits.

At this time the *Offley*, *Juno*, *Sapphire*, and *Pryde* (brig.) were on the Bird Island trade with the *Sapphire* and *Isabella* maintaining the Dunedin service and calling at Bird Island on the homeward run.

The 'Mercury' of October 10th, 1864, reported the arrival of the *Sapphire* from Bird Island via Lady Elliot Island. This island (6° 6′ S. and 152° 40′ W.) is a dependency of the Queensland Government, and was leased to Crowther for a period of ten years from the 10th November, 1863, at a rental of £300 per annum for the first three years. It was also provided that 200 tons of guano per year were to be available for sale at Queensland ports. Other conditions of the lease were very similar to those laid down by His Majesty's Government for the other islands. Shore parties were permanently established on Bird and Lady Elliot Islands, their services being for twelve months, with a relief at the end of that time. They worked on a wage, getting out the guano and bringing it in by trucks to sheds. Here it was bagged ready for transport to the vessels lying at anchor off shore. It was carried between the shore and the ships by whale boats, and these boats were sheathed with metal in order to minimize wear by friction on the coral and also to avoid destruction by the teredo.

This year the *Sapphire* made the voyage out and home in less than six weeks, shipping 360 tons from open boats. The *Isabella, Britons Queen,* and *Offley* brought a series of cargoes—the last-named calling at Auckland. Production generally had been steadily increasing There are no figures for 1860, -1, -2; 1863 - 462 tons; 1864 - 854 tons, and an estimate of 1600 tons for 1865.

An important development now took place. On August 1st, 1865, a prospectus was issued in order to reorganize the Company. The Anglo-Australian Guano Company Ltd. was formed with a capital of £60,000 in 3000 shares each of £20. Henry Hopkins, Esq., was appointed Chairman of Directors. Dr. Crowther accepted £10,000 as purchase-money in fully paid-up shares, and made over to the Company his rights to the guano on the islands leased from His Majesty's Government and the Government of Queensland, as well as ships, various stores, guano in the sheds, with tramways and buildings on the islands.

Captain J. W. Robinson was appointed Manager at Lady Elliot Island, and on September 30th, 1865, landed with his family and twelve labourers, and brought 30,000 feet of sawn timber from the Oyster Cove Mill with which to erect permanent works. Captain Robinson's journal, in the writer's possession, gives details as to the daily routine of collecting and loading guano.

The island itself was a coral island, about 3½ miles long by 2½ miles across, situated about 60 miles from Rockhampton, and was occupied by countless sea birds.

Conditions for ships were greatly improved in 1867, when the *Macquarie* laid down permanent moorings in the hope of attracting overseas as well as inter-colonial trade. Captain Robinson also caused a permanent light to be erected on a mast 85 feet above sea level.

During the Summer (hurricane) months no ships loaded, and the men were employed filling the huts with guano.

Islands in the S. Pacific Area

Teinhourn	10. 20. S. Lat.	150. W. Long.
Roggewein	11. .... S. Lat.	156. W. Long.
Bauman	12. .... S. Lat.	154. W. Long.
Christmas Is.	1. 57. N. Lat.	157. 27. W. Long.
Ducies Is.	24. 40. S. Lat.	124. 48. W. Long.
Cato's Is.	23. 15. S. Lat.	115. 34. W. Long.

In the months preceding the formation of the new Company His Majesty's Government granted to Crowther the lease of the above islands as well as Pilgrim Island and Bramble Cay. He fitted out the *Marie Louise* under Captain Pie to report upon their capabilities and look for new islets. Entering out for Bird Island on January 18th, 1866, she was not reported until her arrival at Brisbane on July 10th. In the interval she had visited the Navigators (Samoa), Ducies Island, Christmas Island, and according to family tradition had sailed nearly to the coast of South America. During this cruise the mate, Mr. Bradley, fell from aloft, and was paralyzed for the remainder of his life.

The barque, *Elgin*, in 1873 found a corked bottle on Ducies Island embedded in a heap of stones. In it was a message which read: 'Exploring vessel *Marie Louise* of Hobart Town off Ducies Island, April 5th, 1866—Crew all well—Bound from here to Christmas Island.' Upon her return she was sold, and was eventually wrecked at the Fiji's in 1871.

In 1866 Crowther had been involved in a controversy with the Tasmanian Government. Approval of leases from the Home Government had not been transmitted to him for six months after their arrival, and in this way he had suffered considerable loss.

By this time the administration of all guano leases from the Antarctic to 10° S. of the Equator and between latitudes 170 W. and 75 E. had been placed under the administration of the Governor of New South Wales. These islands, however, did not carry guano in sufficient quantity, and were not worked by him. In consequence His Majesty's Government in February, 1869, revoked the licences for Teinhourn, Roggewein, Bauman, and Pilgrim Islands upon the grounds that they could not be located, though shown on Admiralty Charts, and also that the stipulated quantity of guano had not been removed from them. The lessee was also required to pay arrears of rent at £100 per annum per island for Ducies, Cato, Christmas, and Raines Islands in addition to such other sums as might be due.

The association of Launceston with the Anglo-Australian Guano Co. Ltd., and the latter year of its work, cannot be dealt with here. Nor can the work of Captain Crosby and the discovery of guano (phosphate rock) at Ocean Island.

With the opening up of the Trans-Pacific Air Routes considerable controversy has arisen between the British Government and that of the United States as to the sovereignity of Christmas Island and other islands. It is of historic interest in this regard that as far back as 1865 such islands were in the possession of Great Britain, and one at least was actually leased to a British subject for the taking of guano.

APPENDIX A

Wrecks and Boat Voyages Associated with Guano Islands

Harp (Schooner)	Lost Bird Is., 1861.
Golden City (Ship)	Lost Bird Is., July 13th, 1866.
Briton's Queen (Schooner)	Lost Mast Head Is.
Cosmopolite (Brig.)	Lost Mast Head Is., Nov., 1866.
Wolverine (Brig.)	Lost Bird Is., with all hands, June, 1878.
Annie (Schooner)	Lost Bird Is., Aug. 2nd, 1882.
Lone Star (Brigantine)	Lost Wreck Reef, Sept. 10th, 1871.
Isabella (Barque)	Lost Cape Barren Is., with guano.

Notable Voyages

Lone Star	Capt. Clark, with three men in a small boat, over 300 miles to the Queensland Coast.
Annie	An almost similar voyage by the ship's boat.
Prairie	Voyage with two men (sole survivors of the crew), west about from Torres Straits to Hobart.
Alice Maud (Cutter, 16 tons)	An exploring voyage, September 27th, 1875, to Torres Straits.
Marie Louise	Exploring voyage, as stated, to S. Pacific Ocean, 1865.

APPENDIX B

Sources of Information

Captain A. B. Robinson, 1865-67	Personally given. Copies of correspondence between his father, Capt. J. W. Robinson, and the A.A. Guano Co., and Harbour-Master of Rockhampton.
Log Books	*Bird Is.*, Oct. 10th, 1873-May 20th, 1874, Captain Strachan.
Log Books	*Lady Elliot Is.*, 11th Nov., 1864-Sept. 12th, 1865. Capt. J. W. Robinson.
Log Books	*Lady Elliot Is.*, . . . 1872-May 3rd, 1872.
Log Books	Barque *Offley*, Jan. 21st, 1864; Dec. 28th, 1864. Capt. J. W. Robinson.

A.A. Guano Company .... **Prospectus, 1865.**

A.A. Guano Company .... **Annual Report, 1869.**

A.A. Guano Company .... **Chart of Bird Is. and MS. letters, W. L. Crowther and Henry Hopkins. List of shareholders and balance-sheets.**

Guano .... **Parliamentary Paper: 1861, No. 38, Tas. Govt.**

Despatches: H.M. Government .... **Lease of Certain Islands: Tas. No. 39. July 5th, 1863.**
Dismission of Leases: Tas. No. 18. Feb. 17th, 1860.

Lease of Lady Elliot Is. .... **Copy of Indenture: Q. Govt.**
Further Correspondence, Aug. 6th, 1866; Oct. 20th, 1866.

Newspapers of the period, especially files of the 'Mercury.'

There is a considerable file at the Mitchell Library dealing with the A.A. Guano Co. Ltd., which the writer has not been able to examine fully.

Most of the above are in the possession of the writer.

PAP. & PROC. ROY. SOC. TASMANIA, 1938 (24TH MAY, 1939)

Relationships of the Tasmanian Canoe-Raft

By

JOSEPH PEARSON

(Read 14th November, 1938)

Perhaps the most primitive type of floating craft still in use is made of bundles of bark or reeds which are tied together. Such a craft has a very short life, and can only be used within a very restricted range. This type was probably followed by the catamaran, (¹) in which two or three logs of wood are tied together. The catamaran, which is still to be found in Southern India, Ceylon, and parts of the East Indies, is a more permanent type than the first, and has a larger range. Frequently a small triangular sail is used, which enables the catamaran to run before the wind at a considerable speed. The dug-out canoe, which might be regarded as the third stage in the evolution of the boat, is still used in many parts of the world, with or without an outrigger. It was succeeded by the planked boat, in which the planks were first stitched together and at a later period were fastened together by pegs or nails.

The object of the present note is to draw attention to the interesting distribution of the first of these types, which is so well-known to students of Tasmanian ethnology. It is not necessary to describe the Tasmanian canoe-raft since adequate descriptions in considerable detail have already been given by various writers, and our knowledge of this subject has been admirably summarized in this Journal (Meston, 1936). Fig. 1 depicts one type of Tasmanian canoe-raft, which consisted of three independent bundles of bark, a larger central

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(¹) Derived from a Tamil word which means literally 'tied-wood.'

one, to which were lashed two smaller lateral bundles. Such a craft was probably pointed at both ends. It is interesting to note that the *balsa*, a canoe-raft used in South America (fig. 2), has a marked affinity with the Tasmanian canoe, though probably more seaworthy. H. Cary Gilson (1938) has given an interesting description of the balsa used on Lake Titicaca. The balsa is a raft consisting of huge bundles of sedge, known as *tortora (Scirpus tortora)*, which are tied together with ropes of plaited grass. These craft last for only about two or three months, after which they break up and are then eaten by the cattle. Gilson describes two types, a smaller craft 8 to 10 feet long, which carries one man, and a larger kind, used for general transport, which may be as much as 20 feet long, and which carries a matting sail made of tortora (shown in the stern of the boat, fig. 2). I understand that the balsa is also used in the sea along the Peruvian coast, but I have no confirmation of this.

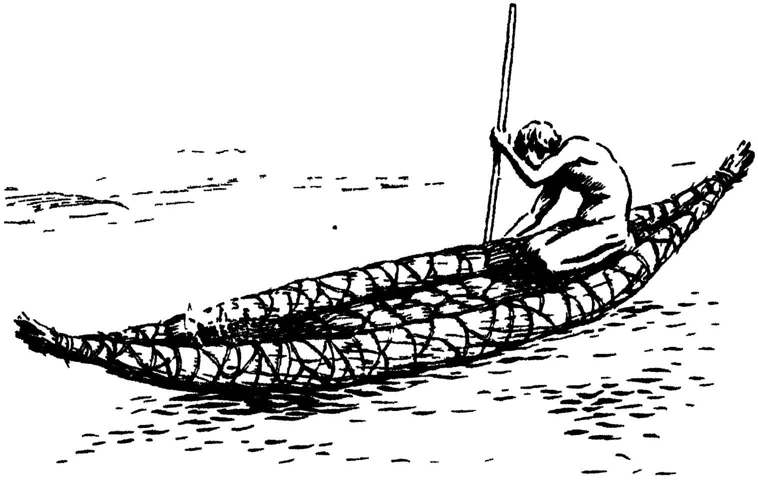

Fig 1 —Tasmanian bark canoe-raft (after a small model in the Tasmanian Museum)

A third type of craft which is used on Lake Tana, Abyssinia, is shown in fig. 3. I have been unable to obtain a precise description of this canoe, but it is apparently made of reeds, which are lashed together. This craft is probably somewhat similar to the one used on Lake Chad, Central Africa, of which a short description is given by P. H. Lamb (1921). The canoe-raft of Lake Chad is made of reeds, and Lamb states that the life of such craft is not more than one month. It is interesting to note that a somewhat similar type of boat was used by the Egyptians about 3500 B.C. The Egyptian type differed from the Abyssinian in having a high prow and stern, and was similar in this respect to one type of Tasmanian canoe-raft.

Thus, the same general type of canoe-raft is found in three widely separated parts of the world. What is the explanation of this discontinuous distribution?

In the field of Biology there are many instances of organisms bearing close resemblances to each other which are found thousands of miles apart. In most cases this common likeness is due to a common descent (homogeny), and the broken distribution marks the outposts of what was once a large continuous area within which these related forms had arisen from a common ancestral type. In some cases, however, the resemblances are produced merely by the convergence of unrelated forms towards similarity of structure, due to the effects of similar environmental conditions (homoplasy).

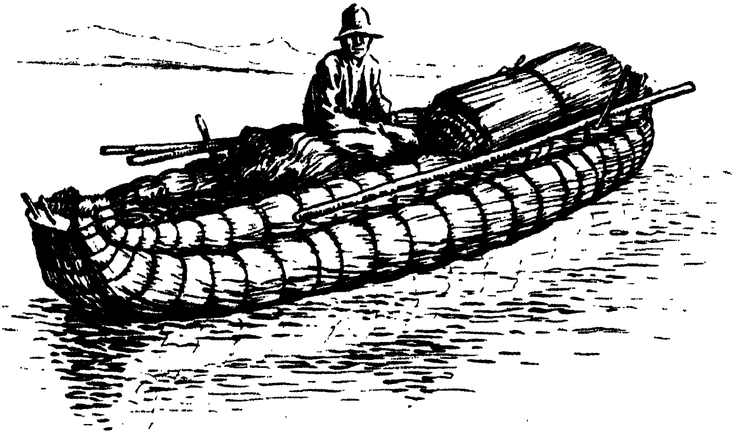

Fig. 2.—*Balsa*, Lake Titicaca (after H. Cary Gilson, by courtesy of the Editor, *The Geographical Journal*).

If it is legitimate to make use of this biological parallel in the present case, it would appear either that these primitive canoe-rafts had a common origin, scattered and broken though their distribution has become, or, on the other hand, that they may have arisen independently in several widely-separate parts of the world in response to similar requirements in a similar set of circumstances.

The solution of this interesting problem has an important bearing on another question, viz., the route by which the Tasmanian aborigines reached Tasmania. If, as it is widely believed, they came by slow stages down the east coast of Australia after having reached that continent from the neighbouring islands of the West Pacific or the East Indies, then it is reasonable to suppose that they brought with them, as part of their primitive culture, the art of making bark canoe-rafts—an art which they retained to the end of their days. If such were the case, the Tasmanian canoe-raft was probably a homogenetic structure and came from the same common stock from which the African and American canoe-rafts arose. It is conceivable that these products of an early and primitive culture were evolved near the cradle of the human race, which is said to have been somewhere near the south-western part of Central Asia. From that focal centre the primitive craftsmanship would radiate in all directions where the absence of geographical and climatic barriers permitted, either by the actual migration of races who carried with them their special ethnological characteristics, or by means of the actual diffusion of culture from one race to another. Both influences were undoubtedly at work, and it is not difficult to visualize how the use of the canoe-raft would spread in may directions for a considerable distance from its point of origin and ultimately would cover a very large geographical area. In course of time this area would tend to become broken either through the abandonment of the handicraft by some races, or because, in the hands of a race possessing a relatively high degree of intelligence, it would be changed into something quite different. Biologically speaking, this may be regarded as a reasonable homogenetic explanation of the occurrence of the bark or reed canoe-rafts in three isolated parts of the world far removed from their probable centre of origin, and would incidentally explain how the canoe-raft came to Tasmania.

On the other hand, Professor Wood Jones (1935) has written strongly in favour of the view that the aborigines reached Tasmania direct by sea from their earlier home somewhere in the West Pacific. Such a view postulates the possession by the early Tasmanians of ocean-going canoes and not the primitive unseaworthy canoe-raft which we know they possessed in their last years. In support of his thesis that the Tasmanians once possessed the art of making sea-going canoes, which at a later period they lost, Wood Jones wrote as follows (1935, p. 8.) 'we know quite well that a race that has come

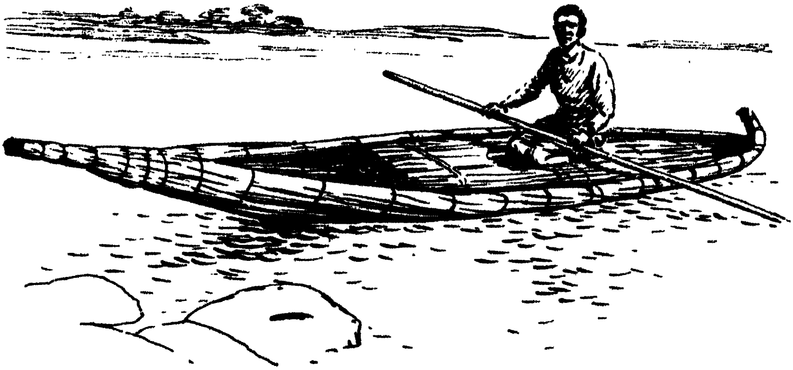

Fig 8.—Primitive canoe-raft, Lake Tsana, Abyssinia (after a photograph published in *The Auckland Star*).

by sea to a new home may, in the end, forget the craft of boat-building, *when ocean voyages are no longer required* (¹). Even if the Tasmanians had possessed no knowledge of boat and boating during the period of European contact, the claims for their seacoming would not necessarily have been invalid.'

I have italicized part of the above quotation because therein lies the crux of the position. Tasmania is surrounded by numerous small islands which are separated from the main island by stormy seas and fierce currents, yet there is undisputed evidence that the aborigines visited many of these islands. Obviously, then, there was a definite need for seaworthy boats, and, if the aborigines had possessed such boats when they first arrived, there is every reason to believe that out of sheer necessity they would have retained the important art of boat-building.

If Wood Jones is correct, it would follow that the Tasmanian bark canoe-raft was probably evolved independently in Tasmania and had no relationship with similar types of raft in other parts of the world, and was, in fact, a remarkable example of convergence.

It does not come within the scope of the present paper to examine critically the various arguments which Wood Jones has put forward in support of his view, particularly as this has already been done to some extent by Meston (1937), or to weigh the evidence regarding the homogenetic or homoplastic origin of the canoe-raft.

It may be said, however, that not one shred of material evidence has been adduced in support of the view that the Tasmanians once possessed the art of building sea-going canoes. My personal opinion is that the primitive canoe-raft of the Tasmanians was a homogenetic cultural product brought by them from their original home and retained by them throughout their long and protracted journey eastward along the islands of Southern Asia and southward down the eastern coast of Australia to their final home in Tasmania.

I am indebted to Captain D. Colbron Pearse for the figures which illustrate this paper.

(¹) The italics are mine.

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The Royal Society of Tasmania

Annual Report

1938

The Annual Meeting was held in the Society's Room, Tasmanian Museum and Art Gallery, Hobart, on the 14th March, 1938.

The following office-bearers were elected:—

Vice-Presidents: Dr. A. N. Lewis (for one year).
Dr. W. L. Crowther (for two years).
Treasurer: Mr. S. Angel.

The following members of Council were elected:—

Mr. W. H. Clemes (retiring 1939).
Professor A. L. McAulay (retiring 1939).
Mr. W. H. Hudspeth (retiring 1940).
Mr. J. W. Evans (retiring 1940).
Hon. L. M. Shoobridge (retiring 1941).
Mr. E. E. Unwin (retiring 1941).

The Council made the following appointments at its first meeting:—

Secretary and Librarian: Dr. Joseph Pearson.
Assistant Librarian: Mrs. Clive Lord.
Standing Committee: Dr. A. N. Lewis, Dr. W. L. Crowther, Mr. W. H. Hudspeth, and the Secretary.

The Council elected the following five Trustees to serve on the Board of Trustees of the Tasmanian Museum and Art Gallery and the Botanical Gardens:—W. H. Clemes, W. L. Crowther, W. H. Hudspeth, A. N. Lewis, and L. M. Shoobridge.

The Society's President, His Excellency Sir Ernest Clark, K.C.B., K.C.M.G., C.B.E., went to England on leave from May to September and the Secretary, Dr. Joseph Pearson, was on leave in England for six months. During his absence Mr. J. W. Evans acted as Secretary.

Nine meetings have been held during the year (see proceedings for abstract of papers). In addition scientific papers were submitted for publication and have been printed in the present volume.

Library

The Society's Library continues to be used extensively by members. During the year 283 new volumes were added to the Library as gifts from 274 institutions in exchange for the Society's Papers and Proceedings and by purchase. The Library now consists of 19,267 volumes. The Council wishes to place on record the valuable work done by Mrs. Clive Lord, Assistant Librarian.

During the year a new type of book cover was introduced for loose parts of unbound volumes. About 1250 covers were made during the year. The Council acknowledges gratefully the following donations towards the cost of the book covers:—His Excellency the Governor, £1; Lady Clark, £1; Dr. W. L. Crowther, £1; Mr. H. Allport, £1; and Mrs. B. Sheppard, 5s.

Membership

The Society consists of the following members:—

	1938.	1937.
Honorary Members	2	2
Corresponding Members	3	3
Life Members	7	7
Ordinary Members	232	231*
Total	244	244

During the year 11 names were removed from the membership owing to deaths, resignations, &c., and 12 new names were added.

The Council regrets having to record the deaths of the following members during the year:—

Life Member: N. Oldham.

Ordinary Members: James Marsh, H. H. Scott, Dr. Stoddart Barr, and Hon. A. Wardlaw, C.M.G.

New Rules

The Rules of the Society have been revised and reprinted during the year.

Index

The Index of the Papers and Proceedings has been brought up to date and it is hoped to publish it during 1939.

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* The number of members given in the Report for 1937 should have read 231 instead of 241.

Clive Lord Memorial Prize

In the present year the Council decided to proceed to the award of the first Clive Lord Memorial Prize, and the conditions governing the award were advertised in the press.

It was decided that the final date for the receipt of essays should be January 31st, 1939.

Printing of Papers and Proceedings

Once again the Government has very generously printed the Papers and Proceedings. The Council wishes to record its appreciation of this generous assistance.

Abstract of Proceedings

1938

14TH MARCH, 1938

Annual Meeting

The annual meeting was held in the Society's Room, Tasmanian Museum. The President, His Excellency the Governor, Sir Ernest Clark, K.C.B., C.B.E., presided.

A vote of sympathy was passed to the family of the late Mr. H. H. Scott, formerly Curator of the Queen Victoria Museum, Launceston, members carrying this standing.

The following were elected Office-bearers and Members of the Council for 1938:—Vice-Presidents, Dr W. L. Crowther and Dr. A. N. Lewis; Treasurer, Mr. S. Angel; Council, Mr. W. H. Clemes, Mr. J. W. Evans, Mr. W. H. Hudspeth, Hon. L. M. Shoobridge, Mr. E. E. Unwin.

Mr. Walter E. Taylor was appointed Hon. Auditor.

Mr. F. H. Foster was elected a life-member of the Society.

Dr. A. N. Lewis explained the alteration of the Society's representation on the Museum and Botanical Gardens Trust under the amendment of the Tasmanian Museum and Botanical Gardens Act, 1885.

Dr. Hickman exhibited some Tasmanian Ascidians.

Dr. C. F. Hodgkinson delivered an illustrated lecture on ' Colourful Ceylon.'

11TH APRIL, 1938

A meeting was held in the Society's Room on this date, the President, His Excellency the Governor, presiding.

The following were elected members of the Society:—Miss Josephine Peterson, Mr. R. B. Wood, Mr. J. L. Somerville, Mr. T. Raphael, Mr. N. J. B. Plomley, Mr. M. P. Crisp, Mr. R. A. Sherwin.

Dr. Lewis exhibited several specimens of Tasmanian Trilobites.

Dr. H. D. Gordon gave an illustrated lecture on ' Seaweeds,' of which the following is an abstract:—

> There are three classes of seaweeds—green, brown, and red. This classification is not so arbitrary as it sounds, for the differences in colour are associated with important differences in structure and life history. All seaweeds contain the green pigment chlorophyll, but some have additional pigments which mask the green colour. These pigments seem to be of importance in relation to the quality of light penetrating to various depths in the water; generally speaking the green seaweeds occur fairly near high-water mark, the browns can extend much farther down, whilst the greatest depths are achieved by some of the reds. Ability to withstand drying is also an important factor controlling the distribution of various species

above low water mark, and may lead to their arrangement in distinct zones. Some species are not confined to one zone, but are to be found higher up the tide range in summer than in winter, or vice versa, in response to the seasonal changes in temperature and light intensity respectively.

As seaweeds absorb their food-materials all over their surface, and not through any root system which must live in the soil, they may grow attached to rocks, &c., or to other seaweeds, and in fact practically every seaweed of any size can be found to have smaller ones attached to it, though they are very seldom parasitic. The uniformity of the aquatic environment is reflected in a relatively simple anatomical structure, though the external forms of seaweeds are extremely varied.

Every substance occurring on the land finds its way, in greater or less quantity, into the sea, and an extraordinary variety of substances is absorbed by seaweeds and can be extracted from them. Iodine is prepared commercially in this way—a process which will become more important as other sources are exhausted. The iodine and other elements found in seaweeds give them a considerable food value, and refined food products have been prepared from seaweeds, whilst "Dulse" (*Rhodymenia palmata*) and others are eaten in their natural state in various parts of the world. Most seaweeds yield large amounts of gelatinous substances and several are used in cookery for that reason, especially *Chondrus crispus*, or Irish Moss, which is also used in the preparation of cosmetics, paints, boot polish, shaving soap, and a variety of other products, besides having medicinal importance as a demulcent. Some seaweeds accumulate lime and play a part in the formation of coral reefs.

A number of lantern slides were used to illustrate the structure and the reproductive processes of various types of seaweeds, and a collection of mounted specimens of British and Tasmanian seaweeds was exhibited.

Dr. Lewis took the opportunity of wishing His Excellency God-speed and a safe return from England, and His Excellency replied briefly.

9TH MAY, 1938

A meeting was held in the Society's Room. In the absence of the President, Dr. A. N. Lewis presided.

The following members were elected:—Mr. M. C. Taylor, Mr. F. W. Hicks.

Mr. Henry Allport spoke about encroachments on certain streets in Hobart and exhibited original grants of town allotments.

Mrs. J. A. McElroy gave a paper (read by Mr. W. H. Hudspeth) on 'Lieutenant-Governor Collins and his Royal Marines,' of which the following is an abstract:—

The paper dealt briefly with Collins' military record, his part in the establishment of the colony at Port Jackson and his history of the first years of the settlement there. Then followed a sketch of the formation and distinguished achievements of the Royal Marine Corps, a detatchment of which formed Collins' military force at the founding of Hobart, and an extract from his Garrison Order Book showed the pride with which he ordered a thanksgiving service for the victory of Trafalgar, even though his settlement was on the verge of starvation. Governor Collins' undoubted memorial, raised by his contemporaries and called after him, was old St. David's Church, and, so far, there is no evidence to show that the wooden building begun near his grave in the burying-ground was ever completed, consecrated, or used for Divine Service. The existing monument, with the badge of the Royal Marines, was sanctioned by Governor Arthur and erected in Sir John Franklin's term of office.

Dr. W. L. Crowther read a paper on 'The Guano Islands of the 60's and 70's' (see p. 213 of the present volume).

Mr. S. Angel read a paper on 'Notes on the last of the Tasmanian Race,' of which the following is an abstract:—

At the beginning of the Nineteenth Century, when the sealing industry flourished in the Bass Strait, it was a common practice for the sealers, who were mostly escaped convicts or ticket-of-leave men, to abduct native Tasmanian women to assist in capturing the seals. In the search for new sealing grounds most of the islands off the southern coast of Australia were visited, and Kangaroo Island (South Australia) became a favourite resort, as it provided salt for the preparation of the skins and had the advantage to them of being outside the jurisdiction of the Van Diemen's Land Government.

There are records of several Tasmanian women who lived on Kangaroo Island prior to the colonisation of South Australia in 1836, but, unfortunately, details of their lives have not been officially kept, so that there is some doubt as to the dates of their deaths. The Southern Australian Census for 1866, in dealing with the native population of Kangaroo Island, records 'Four natives of Van Diemen's Land' and several old residents have stated that 'one, if not three,' of them survived after the death of Truganini in 1876. Only one of these women (Betty Thomas) left any children, namely, a son who went to sea, and two daughters afterwards known as Mrs. Mary Seymour and Mrs. Simpson. Grandsons of Betty named Stanford ('Tiger') Simpson and Joseph Seymour were interviewed by Mr. Norman B. Tindale of the Adelaide Museum in 1936 and were able to direct him to the site of two old huts where several flint implements of Tasmanian facies were found. They also supplied a few native phrases said to be in the Hobart dialect which Betty had taught them in their childhood, one word of which appears in Milligan's Tasmanian vocabulary.

Mr. Tindale has been successful in tracing a Minute by the Destitute Board, Adelaide, in dealing with an application for rations on behalf of Mary Seymour, which states:—

> 'There were three Tasmanian women, native blood, living in Kangaroo Island for many years, the last of these aborigines died about six years ago. 8/9/94.'

References in early South Australian history point to at least four Tasmanians living on Kangaroo Island in 1836, namely:—

(1) Sally (known also as 'Bumble-foot' or 'Big Sal'). Taken to Kangaroo Island by Meredith, who was murdered at Yankalilla in 1834. Was tried with 'Suke' for complicity in the murder but discharged. Died near Big Waterfall at Middle River, but date and burial place not exactly known.

(2) Old Suke. According to an old resident, Robert Snelling, she was the last Tasmanian to die, probably in 1888, as per Destitute Board Minute.

(3) Betty ('Polecat'). Taken to Kangaroo Island with 'Puss' by Robert Warlens in 1817 or 1819. Afterwards known as Betty Thomas, mother of Mrs. Seymour and Mrs. Simpson. Her grandson, Joe Seymour, states she died in 1878 near Stokes Bay.

(4) Puss arrived at the island with Betty, see above. Date of death and place of burial not known.

(5) Little Sal. Buried at Springy Water, Stokes Bay, in 1877. Two old residents regarded her as Tasmanian, but others said she was definitely a native of South Australia. Discovery of her remains may possibly be effected.

6TH JUNE, 1938

A meeting was held in the Society's Room. Dr. W. L. Crowther presided.

Mr. A. L. Butler read a paper on 'The Life and Work of John Gould' in connexion with the centenary of his arrival in Tasmania. The following is an abstract of the paper:—

John Gould was born at Lyme Regis, Dorsetshire, England, on 14th September, 1804. When Gould was 14 his father received an appointment in the Royal Gardens at Windsor. There Gould acquired a knowledge of British birds and studied the technique of avi-taxidermy.

In 1827 he was appointed taxidermist to the newly formed Zoological Society in London, a post which he held for about 11 (or 14) years. In 1829 he married Miss Coxen (died 1841). She painted 600 of his bird pictures, mostly from his rough sketches, and afterwards redrew them on stone. In later years his finished drawings were made by Edward Lear, H. C. Richter, and William Hart.

After his marriage he embarked upon a series of ambitious monographs. Owing to difficulties in finding a publisher he decided to become his own publisher, and in the course of half a century he issued in parts a series of publications which make 41 folio volumes with 2999 hand-coloured plates.

In 1830 he produced the *Century of Himalayan Birds.* This was followed by his monograph on *Toucans* (1834), *Birds of Europe*, 5 vols. (1835-37), *Trogans* (1838). In 1837-38 he published his first Australian work, a *Synopsis of the Birds of Australia*, but he soon found that he had not sufficient material to carry on the work, and he took the heroic resolve of going to Australia with his wife and eldest son, J. H. Gould, and an assistant, John Gilbert. They left England on 16th May, 1838, in the barque 'Parsee,' 348 tons, Capt. John McKellar, which arrived at Hobart Town on 18th Sept., 1838. Gould carried letters of introduction to Sir John Franklin, then Lieut.-Governor of Van Diemen's Land. The Franklins showed Mr. and Mrs. Gould the greatest kindness, and Mrs. Gould and her son stayed at Government House, Hobart Town, for nearly ten months while Gould visited the mainland of Australia. Mrs. Gould was staying at Government House when Franklin Gould, the youngest son, was born.

During his stay in Van Diemen's Land Gould received considerable help from Rev. Thomas James Ewing, R. C. Gunn, and many other local naturalists. This assistance was generously acknowledged by Gould in his published works.

Gould returned to England in 1840, and at once recommenced his *Birds of Australia.* By the efforts of Gould and his assistants the number of Australian species had been increased from 300 to 600. The seventh volume of this work was completed in 1848. The total cost of Gould's expeditions to obtain the birds and the expense of publishing the 600 plates was about £2000.

Mention should also be made of Gould's *Birds of Great Britain* (1862-73) with 367 plates, his *Birds of New Guinea*, with 320 plates, commenced in 1875 and finished in 1888 after his death by Dr. Bowlder Sharpe, the *Birds of Asia* (497 plates) commenced in 1850 and completed in 1883 after his death by Dr. Sharpe.

Mr. Butler concluded with an appreciation of Gould's genius as an ornithologist who had first-hand acquaintance with the Australian birds as the result of arduous expeditions into the bush.

Dr. Lewis gave some notes, abstracts of which are given below:—

1. *Productus subquadratus* Morris

Count P. E. de Strzelecki visited Tasmania 1841-42. His geological explorations in the island resulted in the discovery of a large number of fossils, many of which proved to be new to science. One of these, *Productus subquadratus* Morris, was given the vague locality 'Mt. Wellington to Dromedary' by Strzelecki. It is a rare form which, apparently, was not found by succeeding geologists. The single specimen found by Strzelecki is lodged in the British Museum. Dr. Lewis has now discovered several specimens on the slopes of Mt. Wellington and Mt. Dromedary, and these have been sent to Miss K. I Prendergast, of Cambridge, for examination and description. The species would appear to be found very sparingly in the upper permian blue limestone which skirts Mt. Wellington, Mt. Faulkner, and Mt. Dromedary, and is found associated with *Aviculopecten*, *Eurydesma*, and *Spirifer*.

2. *Tasmanian Trilobites*

The work of the palaeontologists Dr. Kobayashi, of Japan, and Dr. Whitehouse, of Brisbane, has thrown new light upon the Tasmanian trilobites, and has added to the interest created in this group by the earlier investigators Charles Gould, Stephens, and Robert Etheridge, Junior. Dr. Lewis records his discovery of a new trilobite area at Junee. It is hoped that papers by Drs. Kobayashi and Whitehouse on this interesting group will be published next year in this Journal.

3. *Glaciation in the Florentine Valley*

Included in his paper 'Notes on Pleistocene Glaciation, Mt. Field to Strahan' (*vide* p. 161 in present volume).

4. *Notes on the Geology of the Russell Falls River Valley*

11TH JULY, 1938

A meeting was held in the Society's Room. Dr. A. N. Lewis presided.

Mr. M. Blackburn was elected a member of the Society.

Mr. J. W. Evans submitted the following papers, which were taken as read:—

1. 'Australian Jassoidea. Part 8.' (See p. 1 of the present volume.)
2. 'A contribution to the study of the Jassoidea.' (See p. 19 of the present volume.)

Mr. A. W. Knight, M.E., B.Sc., A.M.I.E. (Aust.), gave an illustrated lecture on 'Bridge Engineering.'

Mr. Knight said there were some indefinite records of small bridges said to be 2000 years old. The Romans were the real bridge builders of antiquity, and beam bridges resting on piles were the type most popular.

The principles of the arch and suspension bridge appeared to have been known to the inhabitants of India, Japan, China, and Europe for at least 2000 years. The Romans brought the masonry arch to its high degree of development. With the fall of the Roman Empire, bridge construction in Europe came to a stop, and no progress was made until the 17th century.

The first cast-iron bridge was built in England in 1776, and the first iron railway bridge in 1823. About 1890 steel came into vogue, and entirely supplanted the use of iron. Reinforced concrete, which was developed in France, was first used about the same time. The development of those materials enabled longer spans to be constructed, and was the fundamental reason for the development of the modern art of bridge construction. The limits of the art were not yet reached, for the era of long span bridges had only just begun. It would be possible to build a bridge of at least twice the span of any yet constructed.

In bridge designing, Mr. Knight said, simplicity was most important, and the easiest way was the best. Principles of true economy must be applied to every detail. Rigidity was as important an element as strength, and the strength of a bridge was the strength of its weakest part.

Bridges in Tasmania at one time were constructed generally of timber. Their life had been about 25 years, but the period was becoming increasingly less because the quality of the timber was inferior. The policy to-day was to build of better materials, and permanent bridges generally were of concrete or steel.

8TH AUGUST, 1938

A meeting was held in the Society's Room. Dr. A. N. Lewis presided.

Provision was made for the admission of Associate Members.

The aims and scope of the Biological Survey of Tasmania were discussed, and three papers were read.

The following is an abstract of a paper by Dr. V. V. Hickman:—

The Tasmanian Biological Survey was established in 1937. The preliminary aim of the survey is the compilation of complete lists of the flora and fauna of the State. The schools, Tasmanian Field Naturalists' Club, and many persons interested in the study of natural history are giving valuable help by collecting specimens in different localities. Such work is a necessary prelude to the investigation of the distribution of animals, the relation between plant and animal communities, the influence of environment on flora and fauna, &c. Such ecological work is not only of the greatest academic interest, but also of economic importance. Plagues of mice, grasshoppers, thrips, aphis, &c., are special cases of a regular phenomenon of periodicity in numbers. A knowledge of the biotic factors responsible for these periodic increases in animal populations can be gained only by a careful biological survey carried out over a number of years. The survey may also provide useful data in regard to the advisability or otherwise of introducing foreign animals and plants into Tasmania, the biological control of pests, and the nature and quantity of trout-food in the lakes and streams at different seasons of the year.

Lantern slides of certain apparatus used in biological survey work were shown.

The following is an abstract of a paper by Mr. J. W. Evans, M.A.:—

A brief account was given of the geological history of Australia since Upper Permian times, and of the principal sources from which the Tasmanian fauna is drawn, special mention being made of the connexions with Antarctica. This was followed by an account of certain animals, largely invertebrates, which occur in Tasmania and which are of outstanding interest. In conclusion it was stated that much remained to be learnt about the fauna of the island, and that it was certain that many new forms awaited discovery.

The following is an abstract of a paper by Mr. D. Martin, B.Sc.:—

The Botanical aspect of the Biological Survey was divided into four parts:—

1. The necessity for reviewing past work, cataloguing, and, if possible, obtaining copies of literature.
2. The locating of type specimens and overhauling and checking specimens in the local herbaria.
3. The completion of 1 and 2 then shows the gaps in our collections and allows us to judge the importance of any new material.
4. A statement of the present position.

The deficiencies in our knowledge of the vegetation was then approached from three aspects:-

From the point of view of the species individually.
The vegetation as a whole in relation to the rest of Australia and the world.
The interrelation and association of species in the field.

Lantern slides were shown illustrating climax and seral communities on Mt. Wellington.

12TH SEPTEMBER, 1938

A meeting was held in the Society's Room on this date. Dr. W L. Crowther presided.

Mr. T E. Doe was elected a member of the Society.

Dr. A. N. Lewis read a note concerning R. M. Johnston's 'Geology of Tasmania,' which was published 50 years ago. It was published on 1st September, 1888, and laid on the table of the Society on the 2nd Monday of September, 1888. Although R. M. Johnston was not the first to work at Tasmanian Geology, he may be, nevertheless, given the title of 'Father of Tasmanian Geology.' His book was printed and published by the Government, who also awarded him the sum of £500. In addition to being a first-class Geologist, R. M. Johnston was also a Botanist of repute, and he also made valuable contributions to our knowledge of sea fish and other animals.

Mr. J. C. Wyett, B.Sc., gave an illustrated lecture on 'The Biochemistry of Digestion.' He dealt with the various digestive roles played by the different parts of the alimentary canal. The stages of digestion were illustrated by a motion picture film.

10TH OCTOBER, 1938

A meeting was held in the Society's Rooms. His Excellency the Governor presided.

On behalf of the members of the Society, Dr. W. L. Crowther welcomed His Excellency upon his return from a trip to Europe.

Dr. W. Arundel Orchard, O B.E., D.Mus., F.R.C.M., gave a lecture on 'Shakespeare and Music.' The lecture was illustrated by coloured drawings of various contemporary instruments.

In his introductory remarks Dr. Orchard dealt with the music of the 16th century, with particular reference to contemporary composers and to the interest shown in music by Henry VIII and Queen Elizabeth. He emphasised the influence of Shakespeare's Plays and Poems on Musicians from Thomas Morley (16th cent.) to Chausson (20th cent.). Descriptions of contemporary stringed and wind instruments were given, and the lecturer quoted passages from Shakespeare's plays to prove that Shakespeare had a profound knowledge of music and musical instruments. At various intervals during the lecture gramophone records of 16th century music were given.

14TH NOVEMBER, 1938

A meeting was held in the Society's Room, the President, His Excellency the Governor presiding.

Mrs. D. Archer was elected a member of the Society.

The following papers were laid on the table and taken as read:—

C. G. Stephens and R. F. Cane—'The Soils and General Ecology of the North-East Coastal regions of Tasmania' (printed in full in the present volume, p. 201).

Ellen Clark: 'Tasmanian Parastacidae' (printed in full in the present volume, p. 117).

E. O. G. Scott: 'Observations on some Tasmanian Fishes, Part IV.' (printed in full in the present volume, p. 139).

A. N. Lewis: 'Notes on Pleistocene Glaciation, Mt. Field to Strahan' (printed in full in the present volume, p. 161).

The following papers were read:—

W. H. Hudspeth: 'A Portrait of the Rev. John West.'
'A Pioneer Architect—James Blackburn.'

A number of Blackburn's Plans were shown and the Paper was illustrated by lantern slides.

W. E L. H. Crowther: 'Tasmanian Aboriginal Remains found at Dromedary' (printed in full in the present volume, p. 209).

J. Pearson: 'Relations of the Tasmanian Canoe-raft' (printed in full in the present volume, p. 221).

J. Pearson: 'Frescoes in the Empire Hotel, Elizabeth-street, Hobart.' Photographs of these frescoes were taken before the old building was pulled down. It was stated, without confirmation, that these frescoes were painted by Gould the convict artist. The photographs have now been placed on exhibit in the Museum.

Northern Branch

Annual Report, 1938

In the 1938 Session all meetings, other than the Annual Meeting and Public Lecture, were held in the lecture-room at the Queen Victoria Museum and Art Gallery. An appeal was made that books and records relating to the early history of Tasmania be deposited with the Branch for permanent custody.

23RD MAY, 1938

Annual Report and Public Lecture

Mr. W. R Rolph took the Chair. The following members were elected to the Branch Council for the forthcoming session:—Mr. F. Heyward (Chairman), Hon. Tasman Shields, Messrs. D. V. Allen, J. R. Forward, J. E. Heritage, A. L. Meston, R. S. Padman, W R. Rolph, and E. O. G. Scott. Mr. N. J. B. Plomley was elected Hon. Secretary and Mr. R. S. Padman re-elected Hon. Auditor.

The statement of accounts, showing expenditure of £5 6s. and credit balance of £31 0s. 10d , was adopted.

The annual meeting was followed at 8 p.m. by a public meeting, Mr. W. E. Masters, B.A., LL.B., speaking on 'The Semaphore Telegraph System of Early Van Diemen's Land.'

20TH JUNE, 1938

Mr. V. Sydes was to have spoken on 'Modern Radio,' but the meeting had to be cancelled.

25TH JULY, 1938

Mr. W. R Rolph took the Chair. Illustrated lecture: 'Footnotes to Tasmanian History from Epitaphs,' by Mr. F. Heyward.

23RD AUGUST, 1938

Mr. F. Smithies presided. Mr. H. J. King showed 'Colour Moving Pictures of Tasmanian Natural History and Scenery.'

20TH SEPTEMBER, 1938

Mr. F. Smithies took the Chair. Mr. J A. Dumaresq lectured on 'Veterinary Science and some of its Modern Developments.'

COUNCIL MEETINGS

Meetings of Council were held on: 16th February, 18th May, 15th June, 20th July, 14th September, 20th October.

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